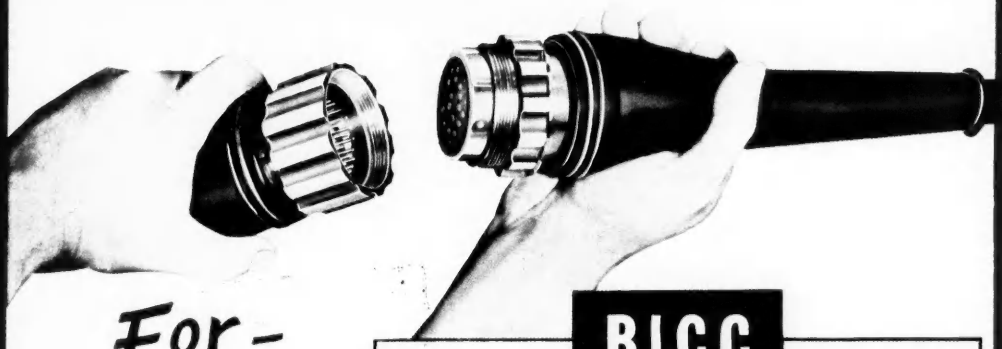
Electronic Engineering



For –

- *Specialised remote control.*
- *Centimetre radio links.*
- *Ground radar.*
- *Outside broadcast.*
- *Television.*

and similar applications.

BICC

POLYPOLE

moulded on

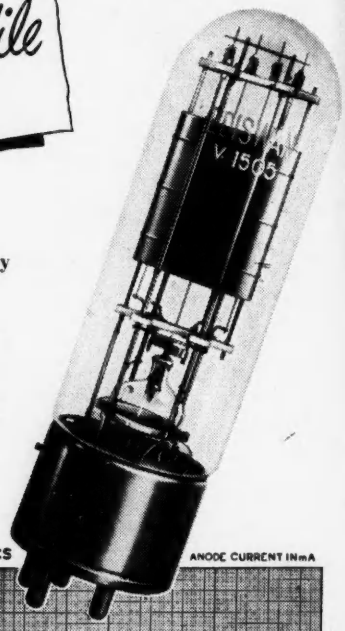
CABLE COUPLERS

PUBLIC LIBRARY
APR 12 1954
DETROIT

If you are interested in the uses of BICC Polypole Cable Couplers, we will be pleased to send you further information.

BRITISH INSULATED CALLENDER'S CABLES LIMITED BI Callender's **21, BLOOMSBURY ST., LONDON, W.C.1. MUSeum 1600.**

DATA for the Designers File



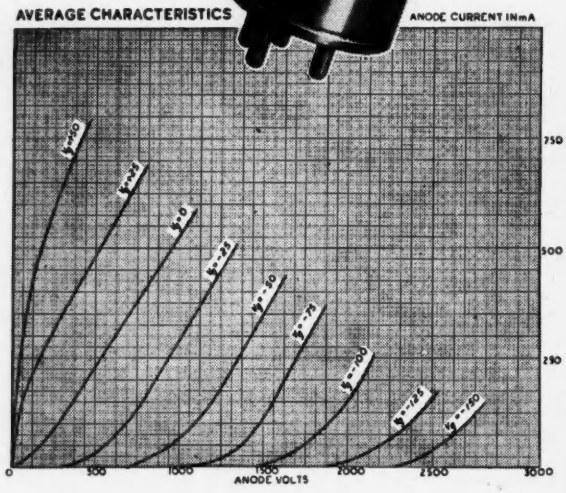
If you are designing Audio Frequency Amplifiers it is highly probable that you will need the Ediswan V. 1505.

The Ediswan V. 1505 is a radiation cooled triode with a directly heated thoriated tungsten filament and anode dissipation of 275 watts. A pair of these valves in push-pull can provide an audio power output of approximately 1,000 watts. It is equivalent to the American Type 212E.

RATING

Filament Voltage	**14 volts**
Filament Current	**6.5 amps**
Maximum Anode Voltage	**3,000 volts**
Maximum Filament Emission	**4 amps**
Maximum Anode Dissipation	**275 watts**
Mutual Conductance (gm)	**8***
Amplification Factor	**16***
Anode Impedance (r_a)	**2,000 ohms***
Maximum Operating Frequency at full rating	**1.5 Mc/s**
Audio Power Output	**1,000 watts (2 valves)**

** Taken at V_a = 2,000 volts; I_a = 150 m/A.*



The Savage V.L.F. Amplifier incorporates the V. 1505

This amplifier has been designed to supply power at low frequency for Vibration Research and Testing. The continuous output rating is 1,000 watts at frequencies from 6 c/s to 2,000 c/s

EDISWAN

INDUSTRIAL AND TRANSMITTING VALVES

THE EDISON SWAN ELECTRIC CO. LTD.,
155 CHARING CROSS ROAD, LONDON, W.C.2
Member of the A.E.I. Group of Companies

EV130

CLASSIFIED ANNOUNCEMENTS

The charge for these advertisements at the LINE RATE (if under 1" or 12 lines) is: Three lines or under 7/6, each additional line 2/6. (The line averages seven words.) Box number 2/- extra, except in the case of advertisements in "Situations Wanted," when it is added free of charge. At the INCH RATE (if over 1" or 12 lines) the charge is 30/- per inch, single column. Prospectuses and Company's Financial Reports £14. 0s. 0d. per column. A remittance must accompany the advertisement. Replies to box numbers should be addressed to: "Electronic Engineering," 28, Essex Street, Strand, London, W.C.2. Advertisements must be received before the 14th of the month for insertion in the following issue.

OFFICIAL APPOINTMENTS

ASSISTANT (SCIENTIFIC). The Civil Service commissioners invite applications for pensionable posts. Applications may be accepted up to 31st December, 1954, but early application is advised as an earlier closing date may be announced either for the competition as a whole or in one or more subjects. The Interview Board will sit at frequent intervals. Age at least 17½ and under 26 years of age on 1st January, 1954, with extention for regular service in H.M. Forces, but candidates over 26 with specialized experience may be admitted. Candidates must produce evidence of having reached prescribed standard of education, particularly in a science subject and of thorough experience in the duties of the class gained by service in a Government Department or other civilian scientific establishments or in technical branches of the forces, covering a minimum of two years in one of the following groups of scientific subjects:—(1) Engineering and Physical sciences; (2) Chemistry, bio-chemistry and metallurgy; (3) Biological Sciences; (4) General (including geology, meteorology, general work ranging over two or more groups (1) to (3) and highly skilled work in laboratory crafts such as glass-blowing). Salary acording to age up to 25: £250 at 18 to £380 (men) or £340 (women) at 25, to £520 (men) or £435 (women); somewhat less in provinces. Opportunities for promotion. Further particulars and application forms from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W1, quoting No. S 59/54. W 3129

BBC REQUIRES ENGINEERS (minimum age 21) of British Nationality for operations and maintenance duties at transmitter, studio, recording and television centres. Must be willing to serve anywhere in U.K. Experience in Radio engineering desirable. Essential qualifications include University Degree, Higher National Certificate or equivalent in Electrical Engineering, Grad. Brit. I.R.E. with maths., or C. & G. Final Cert. in Telecommunications. Promotion prospects. Starting salary £545 with annual increments to maximum £755. Apply: E.E.O., B.B.C., London, W.1, quoting ref EX.4. W 3166

BRITISH EUROPEAN AIRWAYS require an engineer for the maintenance, overhaul and development of Electronic Flight Simulators. Applicants should possess a sound basic knowledge of electronics and have experience in positional and rate servos, accurate repeater mechanism, etc. Commencing salary, while under training, £569 per annum, rising to range £621-£725 p.a. on completion of approximately six months' training. Additional payments are made for any required shift working. Written applications to Personnel Officer, Flight Operations, B.E.A., Keyline House, Ruislip, Middlesex. W 3120

CITY OF GLOUCESTER EDUCATION COMMITTEE. Principal: R. S. Reed, M.Sc., M.I.Mech.E. Applications are invited for the post of Assistant Lecturer, Grade B, in the Department of Electrical Engineering to teach Electrical Engineering subjects up to Higher National Certificate and Endorsement Standard. Salary in accordance with the Burnham Technical Award. Application forms may be obtained from the Principal, Gloucester Technical College, Brunswick Road, Gloucester, to whom they should be returned within fourteen days of the appearance of this advertisement. W 2010

CITY OF WAKEFIELD EDUCATION COMMITTEE. Wakefield Technical College. Principal: G. N. Blair, M.C., B.Com., A.C.I.S., F.I.I.A. A Senior Laboratory Steward is required for the Department of Engineering and Mining. Duties will be primarily concerned with the Electrical, Mechanics and Physics laboratories. Salary Scale £340 × £15 × £5 = £390 per annum. Applications are invited from men who have served an apprenticeship, preferably in some branch of engineering. Previous experience as a laboratory steward, although not essential, is desirable. Experience of storekeeping or of simple maintenance work would be an advantage. Further information regarding nature of work, hours of duty, superannuation, holidays, etc., may be obtained from the undersigned on receipt of a stamped addressed envelope. Applications should be returned within 15 days of the issue of this advertisement. C. L. Berry, Director of Education. W 3121

ELECTRONICS ENGINEERS AND PHYSICISTS required by Ministry of Supply Experimental Establishments at Farnborough, Hants; Malvern, Worcs; Sevenoaks, Kent, and elsewhere, mainly in Southern England. Duties include research, development or design of telecommunications and radar equipment; guidance and control systems; instrumentation for variety of research problems. Experience of V.H.F.; pulse techniques; display systems, etc., desirable for some posts. Appointments according to qualifications and experience as Scientific Officer (1st or 2nd class Honours Degree or equivalent) £417-£781; Assistant Experimental Officer (Higher School Cert. (science) or equivalent—Degree or H.N.C. may be an advantage and technical experience in Forces or industry desirable) £264 (age 18)—£576; Experimental Officer (H.S.C., etc., but minimum age 26) £649-£799. Women somewhat less. Appointments unestablished. F.S.S.U. benefits may be available for S.O. class. Applications forms from M.L.N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D 480/53A. Closing date 13th April 1954. W 3173

ELECTRONIC TECHNICIANS. Electronic Technicians (Tech. Grades I & III) are required at Atomic Weapons Research Establishment, Aldermaston, Berkshire, to comprise a team responsible for the maintenance and efficient operation from the electronic aspect, of an electronic digital computer. A recognized engineering apprenticeship or equivalent training in an appropriate trade is essential together with a wide knowledge and experience of electronic work, in particular pulse techniques. A period of training with a firm of electrical contractors will be necessary. Salary—Tech. Grade I £702 rising to £848. Tech. Grade III (£480 (at 26) rising to £597. Housing accommodation available within a reasonable time for successful candidate if married. Applications to Administrative Officer, Recruitment, A.W.R.E., Aldermaston, Berkshire, quoting ref. 43/W.G.E. W 2014

ELECTRONICS TECHNICIAN required to undertake practical work of construction and maintenance of Electroencephalographic and other electro-medical equipment. Applicant should have a good working knowledge of electronic theory and practice. Practical workshop experience essential. Salary according to experience and qualifications. Apply, giving full particulars, to The Physician Superintendent, Crichton Royal Hospital, Dumfries. W 1960

LONDON COUNTY COUNCIL. South East London Technical College, September 1954. Senior Lecturer to teach and develop the subject of Industrial Electronics (as distinct from Telecommunications). Should be graduate with industrial experience in the subject. Ability to teach Electrical Technology an advantage. Burnham (Technical) salary scale, at present £1,040 × £25 to £1,190, plus London Allowance £36 or £48. Application forms from Secretary at College, Lewisham Way, S.E.4, for return by 23rd April. (251). W 3200

MINISTRY OF SUPPLY invites applications for a limited number of Senior and Junior Fellowships tenable for three years at the Radar Research Establishment, Malvern, Worcs, commencing in autumn, 1954. Candidates must be British subjects with either a First or Second class Honours Degree in an appropriate subject and must be able to show evidence of a very high standard of ability in research. Fellows will be allowed considerable choice of subjects within the fields of interest to the Establishment. These include experimental and theoretical research in low temperature physics, electrical and optical properties of semi-conductors, infra-red spectroscopy, microwave physics, and electronics. For Junior Fellowships candidates should have had at least two years post-graduate research experience and should preferably be aged 23 to 26; candidates for Senior Fellowships should have had at least three years' post-graduate research experience and should preferably be aged 26 to 30. Remuneration will depend on individual merit and will be between £800-£1,000 per annum for Senior Fellows and £500-£700 per annum for Junior Fellows, both carrying benefits under F.S.S.U. At the expiry of a Fellowship a holder may be considered for an established post at the Establishment if he so desires. Application forms are obtainable from the Director, Radar Research Establishment, Malvern, Worcs, to whom they must be returned by 30th April, 1954, together with suitable testimonials regarding research ability, and, where possible, copies of candidates' published papers. W 3199

MINISTRY OF SUPPLY requires Engineers in London H.Q., to help plan progress production of (a) complex airborne radar equipment or (b) all types electronic test gear. Qualifications, British of British parents. Recognized engineering apprenticeship and A.M.I.E.E., A.M.I. Mech.E., or A.M.I.C.E. or exempting qualifications. Suitable practical production experience and good knowledge of electrical and radio engineering Salary within £650 (age 25)—£1,000. Not established but opportunities to compete for establishment may arise. Exceptionally, applicants without A.M.I.E.E., etc., but having evidence of appropriate experience and high attainments may be considered. Application forms from M.L.N.S., T. & S.R. (K), 26 King Street, London, S.W.1, quoting: (a) D173/54-A or (b) D174/54-A. W 2013

NATIONAL COAL BOARD invite applications for the undermentioned superannuable appointments at the Central Research Establishment, Isleworth, Middlesex. The work undertaken is on fundamental principles and staff are required for the following fields:—(1) Problems in the control and improvement of working conditions in mines; (2) mechanical properties of coal of relevance to coal winning; (3) technical methods of coal winning; (4) design of experimental coal-getting machinery; and (5) instrumentation for use in mines and laboratory in connexion with the above problems. Scientists. —Candidates should have a first or second class Honours Degree (or equivalent qualification) in Physics, Mathematics or Engineering. Some post-graduate research experience cognate to the above studies is desirable and work in the following fields would be particularly applicable:—Heat and thermodynamics; properties of gases; properties of matter; elastic and plastic properties of materials; strength of materials; friction; applied mechanics; fluid flow; design of experimental machinery and devices; technique of measurement of stress and strain; recording apparatus; electronic circuit design. Appointments will be, according to qualifications and experience, as either Scientist Grade II (£645 × £30 to £1,095 per annum male, and £545 × £25 to £795 × £30 to £945 per annum female), or Scientist Grade III (£445 × £25 to £845 per annum male, and £420 × £20 to £720 per annum female). London location allowance of £32 10s. at the minimum rising to £78 per annum at the maximum of the scales, is payable in addition. Reference No. TT/743. Physicists and Engineers for appointments as Scientific Technical Officers. Staff are required for the field of technical problems arising in coal transport, roof support, etc., in addition to those fields quoted above at (1) to (5). Appointments will be, according to qualifications and experience, as Scientific Technical Officers either Grade II (£485 × £20 to £705 per annum male, and £390 × £16 to £566 per annum female) or Grade III (£375 × £20 to £535 per annum male, and £300 × £16 to £428 per annum female). London location allowance of £32 10s. at the minimum rising to £50 per annum at the maximum of the scales, is payable in addition. Candidates should possess a Pass Degree (or equivalent qualification) for S.T.O. II posts and an Intermediate Degree (or equivalent) for S.T.O. III posts. Previous experience in laboratory work or instrumentation would be an advantage. Reference No. TT/744. Write giving full particulars (in chronological order) of age, education, qualifications and experience (with dates) to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking envelope with relevant TT reference No. quoted above. Closing date 9th April 1954. Original testimonials should NOT be forwarded. W 3147

OFFICIAL APPOINTMENTS (Cont'd.)

NATIONAL PHYSICAL LABORATORY, Teddington, Middlesex, requires laboratory workers and designer-draughtsmen in the Assistant Experimental Officer and Experimental Officer grades for the development of electronic computers and other electronic equipment. Age over 18. Qualifications ranging from General Certificate of Education (Advanced Level) to Higher National Certificate or Degree in suitable electrical engineering or science subjects. Inclusive annual remuneration for a 45½-hour week from £282-£626 inclusive according to age and qualifications (somewhat less for women). Posts unestablished but suitable candidates will have opportunities of obtaining established (pensionable) posts through the Civil Service Competitions. Application form from M.L.N.S., Technical and Scientific Register (K), 26/28, King Street, S.W.1. Quoting D175/54-A. W 3198

NEW ZEALAND RADIO ENGINEERS, CIVIL AVIATION BRANCH. Vacancies exist in the New Zealand Public Service for Radio Engineers. Commencing salary between £570 a year and £980 a year plus General Wage Increase limited to 24s. a week. Applicants should have an Engineering Degree specializing in te'ecommunications electronics and/or graduate membership in the Institution of Electrical Engineers or equivalent. They should be competent in one or more of the following:—Design and/or installation of radio communications, navigational aids, radar and electronic equipment. Inquiries relating to nature and organization of duties should be addressed direct to the Divisional Controller of Airways, Civil Aviation Branch, Wellington, New Zealand. Application forms and conditions of appointments may be obtained from the High Commissioner for New Zealand, 415 Strand, London, W.C.2, with whom applications should be lodged not later than the 30th April, 1954. Reference No. A3/47/43 should be quoted on all applications. W 3194

NORTHAMPTON POLYTECHNIC, E.C.1. Instrument Department. Instrument Workshop Technicians required. One with experience of electronic chassis wiring and assembly. Permanent. Forty-four-hour week. Varied interesting work. Five-weeks paid holidays. Scale £300 p.a. at 21 to £393 at 26. Write with full particulars to Secretary. W 3168

QUEEN MARY COLLEGE. (University of London). Research Fellowships in the Department of Electrical Engineering. Applications from Physicists or Engineers are invited for two Research Fellowships for work in the Nuclear Particle Laboratory. Stipends of up to £900 per annum are payable, and appointments would normally be for three years, with possible extention. The candidates appointed would be required to work on either (1) Dielectric-loaded wave-guides and Linear Accelerators, requiring the technique of pulsed, high power R.F. at 10-cm. wave length or (2) High vacuum systems subject to voltages of up to 1 MV, requiring insulation testing and gas discharge techniques. In both cases experience of high-vacuum technology would be of great value. Applications should be made to the Registrar, Queen Mary College, Mile End Road, London, E.1, and should include particulars of experience and academic qualifications. W 3182

TECHNICAL INSTRUCTOR (Broadcasting) required by the Nigerian Government on contract for two tours of 12-15 months. Possibilities of permanency. Salary, etc., according to experience in scale £1,170 rising to £1269 a year. Outfit allowance £60. Free passages for officer and wife and assistance towards cost of children's passages or grant of up to £150 annually for their maintenace in this country. Liberal leave on full salary. Candidates should have had instructional experience at the B.B.C., and must have reached Grade C minus, or above. Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/30305/EK. W 3171

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, Fort Halstead, Kent, requires an Engineer to undertake engineering of special electronic and light mechanical equipment to meet scientists' requirements, with progressing to final small scale production. Applicants should have served a recognized engineering apprenticeship and be corporate members of the Institution of Electrical or Mechanical Engineers, or have exempting qualifications. A good knowledge of special electronic equipment, such as oscilloscopes employing high speed time bases, pulse generators, video amplifiers and stabilized power supply units, is desirable. Knowledge of the mechanical design of electronic equipment would be an advantage. The salary range for this post is from £620 to £960. The post will initially be located at Fort Halstead, Kent, but will later be at Aldermaston, Berks, where housing accommodation will be available for married officers who live outside the Establishment's Transport facilities. Applications should be made to the Administrative Officer, Recruitment, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting reference 33/W.G.B. W 2015

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, Fort Halstead, has a vacancy for a Senior Scientific Officer or Scientific Officer. Applicants should have an Honours Degree in Physics or Electrical Engineering, or equivalent; they should possess a detailed knowledge of ultra high speed pulse techniques and be able to carry out design, development and engineering of special instruments using such techniques. Previous experience in electronics in industry or in Government service is required. The salary ranges are: Senior Scientific Officer £875-£1,033, Scientific Officer £418-£781. Starting pay will be dependent on age, qualifications and experience. Applications should be made to the Administrative Officer, Recruitment, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting reference 22/W.G.E. W 3138

THE NATIONAL PHYSICAL LABORATORY, Teddington, Middlesex, has vacancies for junior staff to assist, in laboratory or drawing office, in work on electronic computors and other electronic equipment. Age 16-26. Salary £215 to £410, acording to age, with regular increments. (Lower maximum for women). Minimum qualification General Certificate of Education at ordinary level in four subjects including English Language and a scientific subject or mathematics. Posts unestablished, with opportunities of established (pensionable) posts, and of promotion to higher grades. W 3141

THE ROYAL TECHNICAL COLLEGE, Glasgow. Natural Philosophy Department. Technician, on salary scale £420 to £510, for duties involving construction and maintenance of electronic equipment. National Certificate or equivalent qualification required. Applications by letter to Professor of Natural Philosophy. W 3128

UNIVERSITY COLLEGE LONDON (Gower Street, W.C.1) has vacancy for Technician in Department of Phonetics. Knowledge of electronics essential and interest in accoustics prefered. Wage scale £315-£15-£450 p.a., plus London Weighting; initial wage according to qualifications. Application forms from Secretary, quoting Phonetics/2. W 3172

UNIVERSITY OF LONDON. Post Graduate Medical School. Electronic Engineer required in the Biophysics laboratories to assist in development of instruments for medical research. Field covered includes electrocardiography, servo-operated resuscitators, optical methods of following blood conditions, strain gauge methods of pressure recording and other applications of electro-mechano tranducers and recording devices for studying conditions in the human subject. The candidate should have a knowledge of D.C. amplifier circuits. The selected candidate, who must be under 33 years of age, will be a member of a small group, in well-equipped laboratories, with good workshop facilities, and must be capable of independent work under limited supervision and guidance. Permanent position for the right person. Salary £460-£540, or up to £625, if the candidate holds a Higher National Certificate or its equivalent. Superannuation under the University of London Pension Scheme after six months' probation. Application forms from The Dean, Postgraduate Medical School, Ducane Road, W.12. W 3186

WIRELESS STATION SUPERINTENDENT required by the Nigeria Government Posts and Telegraphs Department for one tour of 18 to 24 months in the first instance. Option of appointment (a) on temporary terms with salary etc., according to experience in scale £864 rising to £1,392 a year and gratuity of up to £150 a year, or (b) with prospect of pensionable employment with salary, etc., in scale £750 rising to £1,175 a year. Outfit allowance £60. Free passages for officer and wife. Assistance towards cost of children's passages or grant of up to £150 annually for their maintenance in the U.K. Liberal leave on full salary. Candidates must have had a wide practical experience of modern radio techniques and equipment, in particular V.H.F. equipment, and preferably also U.H.F. multi-channel equipment. Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/28927/EK. W 3126

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 *inclusive or a woman aged* 18-59 *inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order,* 1952.

A COMPANY in the West London area requires personnel in the following grades to staff an expanding section engaged on the design, development and small-scale production of electric control systems for aero-engines. (a) Senior Development Engineers.—Salary up of £1,000 p.a. according to qualifications and experience, to have experience of light electromechanical devices of magnetic amplifier techniques. (b) Development Engineers.—Salary up to £750 p.a. according to qualifications and experience to assist in work as above. (c) Test Engineers.—Salary up to £600 p.a. according to experience, to have experience to high-grade testing of complex electro-mechanical equipment. Please write fully, stating qualifications, experience and age to Box No. W 1963.

A JUNIOR DEVELOPMENT ENGINEER is required to assist in the development of precision electronic laboratory instruments. The successful applicant will be engaged on interesting long term projects concerned with the development of a wide range of equipment. The appointment is of a permanent nature, it carries considerable technical responsibility and offers scope for the exercise of individual initiative. Applicants should have had previous experience in development preferably in the instrument field. Academic qualifications ranging from O.N.C. (or an equivalent standard) to a University Degree in Communications Engineering or Physics are acceptable. Salary will be dependent upon age, qualifications and experience. Apply stating full details to:—The Chief Engineer, Furzehill Laboratories Ltd., Shenley Road, Boreham Wood, Herts. W 193

A LARGE engineering organization in S.W. Lancs, in the light electrical field has several vacancies for Development Engineers for work on circuit design in telecommunications utilizing the properties and potentialities of semiconducting materials. Applicants are invited to write to Box No. 606 Dorland Advertising Ltd., 18-20 Regent Street, London, S.W.1, giving details of age, qualifications, experience and approximate salary sought. Experience in these fields is desirable, but consideration will be given to applicants who are interested in the scope offered by such materials. Positions will be on established staff status with contributory Pension Fund and usual staff conditions. W 3142

A LARGE MANUFACTURING FIRM offer opportunities to Designers of Special Purpose machinery and plant used in the manufacture of Condensers. Originality and versatility backed by practical experience are essential. Candidates must possess a Higher National Certificate, and will be required to handle projects through to successful conclusion, both in the works and while carrying out experiments. Reply to Box No. W 1979.

A LARGE LONDON ENGINEERING COMPANY engaged on the mass production of electronic and electro-mechanical equipment intends to engage a Sales Manager, and invites applications from men with experience in a post of similar responsibility, preferably in an allied industry. A knowledge of production and technical appreciation are desirable qualifications but experience of sales promotion at high levels is essential. This is a senior post and will be remunerated accordingly. Replies, which will treated in a highly confidential manner, should give details of qualifications and experience and be addressed to Box No. W 2016.

CLASSIFIED ANNOUNCEMENTS
continued on page 4

WORLD-WIDE DEMAND FOR STENTORIAN HIGH FIDELITY UNITS

Phenomenal success of new line

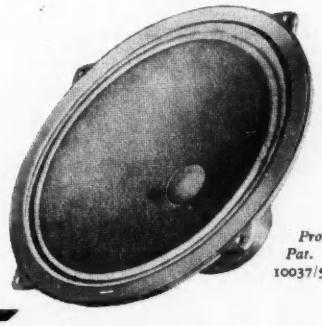
Never before, in all our 28 years' experience of speaker production, have we created a world-wide demand in a matter of months. It sounds incredible, but that is just what has happened with our High Fidelity range. Since they were first introduced at the Radio Show, we have received orders for these units from

U.S.A · CANADA · AUSTRALIA
SOUTH AFRICA · PORTUGAL · BELGIUM · SWEDEN
MEXICO · VENEZUELA · COLOMBIA

and even from behind the Iron Curtain!

In this country, their success has been phenomenal: more than 1,400 users have taken the trouble to write us — a most impressive tribute. The amazing quality of reproduction at remarkable low cost is made possible only by the Whiteley patented Cambric Cone, and by our specialisation and complete control of manufacture from raw material to finished product.

Write for dimensional drawings of suitable cabinets and leaflet giving full technical details, or ask your dealer to demonstrate. Alternatively, these speakers may be heard at our London Office, 109 Kingsway, W.C.2, any Saturday between 9 and 12 noon.



Prov. Pat. 10037/53

Stentorian

HIGH FIDELITY UNITS
WITH THE PATENTED CAMBRIC CONE

MODEL H.F.610.	6" unit,	**£2.10.6**	(Tax Paid)
MODEL H.F.810.	8" unit,	**£3. 0.6**	(Tax Paid)
MODEL H.F.912.	9" unit,	**£3. 7.0**	(Tax Paid)
MODEL H.F.1012.	10" unit,	**£3.12.6**	(Tax Paid)

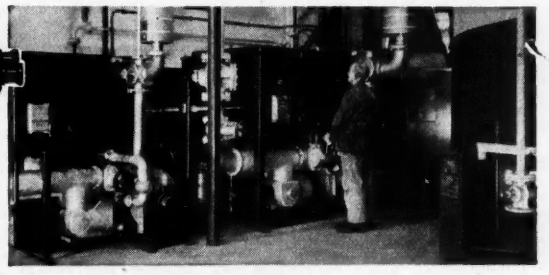
Transformer available if required
All models available either 3 or 15 ohms.

WHITELEY ELECTRICAL RADIO COMPANY LTD.
MANSFIELD · NOTTS

DRY AIR FOR IMPROVED VACUUM WORK

A selection of capacitors for fluorescent lighting equipment and ignition units which are vacuum impregnated faster and better by the installation of a Birlec Lectrodryer. (Right) Two special Lectrodryers designed for working in conjunction with an insulating impregnation tank.
Both photographs are published by kind permission of the British Thomson-Houston Co. Ltd.

Thorough insulation impregnation by alternate vacuum and pressure cycles demands the rigid exclusion of moisture from the system by BIRLEC LECTRODRYERS. BIRLEC LECTRODRYERS are applicable to a number of electrical applications including the dry blanketing of transformers during assembly, the dry storage of delicate components and insulating material and the drying of gases for lamp filling, electrode annealing etc.



Please send me details of LECTRODRYERS for electrical work.

Application.....

Name .....

Company .....

.....

IVW

sm/B.2131. 54

DRYER DIVISION OF
BIRLEC LTD

ERDINGTON
BIRMINGHAM 24

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

APPLICATIONS ARE INVITED from Engineers and Draughtsmen as shown hereunder (a) Design Engineers and Draughtsmen with experience of design of Television, Services Communication Equipment and/or Aircraft Accessories. (b) Tool Design Draughtsmen with experience of small to medium class Press Tools, Jigs and fixtures. The vacancies, which call for men of sound technical ability, offer good progressive positions. A good salary will be paid to the selected applicants and will be commensurate with previous experience. Applications should be addressed, in the first instance, for the attention of The Personnel Manager, The Plessey Company Limited, Vicarage Lane, Ilford, Essex. W 2003

APPLICATIONS ARE INVITED by large Electrical Manufacturers for Engineers to design-develop Domestic Broadcast Radio Receivers. Permanent pensionable posts will be offered to men who have sufficient Technical Background and experience to work with a minimum of supervision. Write stating age, experience and salary required to Box No. W 2002.

APPLICATIONS are invited for posts of Senior and Junior Television Development Engineers. Applicants should have sound technical educations and be fully conversant with modern techniques of television design, and capable of progressing designs through to production stages. Staff Pension Scheme. Five-day week. Applications, giving full details of qualifications and experience and salary expected, to be addressed to The Personnel Manager, Vidor, Burndept Ltd., West Street, Frith, Kent. W 3125

A PRODUCTION MANAGER who possesses considerable experience in the production of all types of Paper Dielectric Capacitors is required by a large Manufacturing Company. The position carries high remuneration and only men of proved ability in this field of electronics need reply. Applications, stating age, qualifications, experience and salary requirements, should be addressed, in confidence, to Box No. W 1980.

ASSISTANT ELECTRONIC ENGINEERS and technical assistants are required to take part in an extensive design and development programme ranging from precision audio oscillator to microwave equipment. Present developments include encapsulated sub-miniature techniques involving the use of transistor circuits. There are excellent opportunities for junior engineers to gain valuable experience so that they may in due course occupy positions of technical responsibility within the Company. Applicants should either possess a Degree or be studying to that end. Write to The Wayne Kerr Laboratories Ltd., Sycamore Grove, New Malden, Surrey. W 1969

A WEST MIDDLESEX Manufacturing Company has a vacancy for a qualified mechanical or electrical engineer, preferably Degree or Higher National Certificate, with electronic experience. Applicant must have experience of plant operation and factory engineering allied to electronic control of processes. Post offers excellent opportunity to man with progressive outlook. Age 30 to 40. Pension and Profit Participation scheme. Salary dependent upon experience and qualifications. Write giving fullest details of age, qualifications and experience and salary required to Box No. W 3164.

CIRCUIT DEVELOPMENT ENGINEER is required by The English Electric Valve Co., Ltd., at Chelmsford. Applicants should possess a Degree or equivalent and if possible experience of transistor circuitry. Write giving full details quoting ref. 440D to Dept. C.P.S. 336/7 Strand, W.C.2. W 3117

BLACKBURN AND GENERAL AIRCRAFT LTD., have vacancies in the Electronics Section at Brough, for One Senior and Two Junior Technicians for work on strain-gauging, electronic instrumentation and vibration investigations on aircraft and gas turbines. Previous experience of this type of work essential for senior grade and desirable for junior grade. The Company's programme on Military and Civil aircraft offers excellent prospects of permanent and interesting work under congenial conditions at salaries commensurate with qualifications, ability and experience. Applications giving full particulars of age, training, etc., to:—The Personnel Manager, Blackburn & General Aircraft Ltd., Brough, Yorks. W 2001

CHIEF OF TEST required by Airmec to take charge of the Electronic Test Department. Must be able to organize, and to control staff. Experience of A.I.D. procedure desirable. Monthly appointment, with pension scheme. Accommodation may be available. Write giving full details of qualifications and experience to Personnel Officer, Airmec Limited, High Wycombe, Bucks. W 3137

COLOUR TELEVISION. E.M.I. Research Laboratories, Hayes, Middlesex, have vacancies for Graduate Radio Engineers and Physicists for development work on Colour T.V., also V.H.F. and U.H.F. This includes work on tubes and circuits for both receiving and transmitting equipment. Three or four years' experience in similar fields or in academic research is desirable, but there are a few vacancies for graduates with less experience who are not liable for National Service. Apply to Personnel Dept. (RL) E.M.I. Ltd., Hayes, Middlesex. W 2012

COTTAGE LABORATORIES LTD., have a vacancy for a Development Engineer to design coils and transformers. Associated with the position there is also an interesting field of filters and networks, in which the applicant would be trained. This is a good opportunity for an engineer to gain knowledge in an important aspect of electronics. The Company is expanding and the prospects of promotion are excellent. A good salary will be paid to a suitable applicant. The position is permanent and pensionable. Five-day week, good canteen, sports ground and social club. The premises are on the main bus route between Kingston and Guildford. Applicants must be of British nationality and should submit details of age, qualifications, etc., to the Technical Director, Cottage Laboratories, Ltd., Fairmile Cottage, Portsmouth Road, Cobham, Surrey. W 3135

COTTAGE LABORATORIES LTD., have a vacancy for an Assistant Development Engineer to assist in the design of coils and transformers. This is a good opportunity for a young engineer to be trained in an important branch of electronics. The position is permanent and pensionable. Five-day week, good canteen, sports ground and social club. The premises are on the main bus route between Kingston and Guildford. Applicants must be of British nationality and should submit details of age, qualifications, etc., to the Technical Director, Cottage Laboratories, Ltd., Fairmile Cottage, Portsmouth Road, Cobham, Surrey. W 3134

COTTAGE LABORATORIES LTD., have the following vacancies:—Development Engineer. A physical and experimental outlook is desirable. The applicants should be capable of designing modern electronic ciruits. A Degree, or equivalent qualification, is desirable. There are good prospects of promotion in an expanding organization. Assistant Development Engineers interested in electronics. H.N.C., or equivalent, is desirable. The positions are permanent and pensionable. Five-day week, good canteen, sports ground and social club. The premises are on the main bus route between Kingston and Guildford. Applicants must be of British nationality and should submit details of age, qualifications, etc., to the Technical Director, Cottage Laboratories Ltd., Fairmile Cottage, Portsmouth Road, Cobham, Surrey. W 3136

DECCA RADAR LTD. invites applications from Senior Electronic Design Engineers to engineer experimental radar equipment into a form suitable for production. Considerable experience of this type of work is essential, including progressive responsibility through Drawing Office and Electronic Development Laboratory. Applicants should have H.N.C. or equivalent qualifications and be of British Nationality. The post is permanent and pensionable and there are prospects of rapid advancement from a good starting salary. Write, quoting Ref. RLA/18, Decca Radar Ltd., Research Laboratory, 2 Tolworth Rise, Surbiton, Surrey. W 3148

DECCA RADAR LIMITED require a man to assist on radar systems planning, operational research and field trials. Applicants must have sound scientific background, an appreciation of radar applications and some practical field experience of air or marine radar. Write first in confidence to Decca Radar Limited. Ref. R.F.H., 1/3 Brixton Road, London, S.W.9. W 3119

DEPUTY CHIEF MECHANICAL INSPECTOR required by world famous manufacturer of Radio and Radar equipments in the Home Counties. This is a responsible appointment and applications can only be considered from first-class men of good education and technical qualifications, possessing a sound knowledge of light engineering as applied to the manufacture of electronic equipment. Familiarity with machine shop practice, tools and jigs is essential and applicants must be capable of controlling a large A.I.D. approved Inspection Organization. This appointment is permanent and pensionable with good prospects. Applications, which will be treated in confidence, quoting ref. IAA. should be addressed to Box No. W 3124.

DEVELOPMENT ENGINEER age 25/30 with experience of Radio Communication equipment, preferably holding Higher National Certificate or equivalent required by firm in London S.E. area. State age, qualifications, experience and salary required to Box No. W 3123.

DEVELOPMENT ENGINEERS AND TECHNICAL ASSISTANTS required by the Precision Engineering Division of Short Brothers & Harland Ltd., Belfast, for work on Guided Weapons and other interesting projects. Ideal conditions in new laboratories for men with good practical experienece in one of the following fields: —(1) Precision Mechanical Engineering, including Hydraulics or Pneumatic Servos, Medium/Light Mechanisms or Instruments. (2) Small Electro-mechanical Devices, Servos or Instruments. (3) Electronics, preferably D.C. Amplifiers, Electronic Computation, Pulse Techniques or Miniature Equipment. Minimum qualifications—Development Engineers, University Degree or equivalent; Technical Assistants, H.N.C. or C. & G. Finals. Good salaries and prospects for men with initiative. Pension Scheme, assistance with housing. Send full particulars of age, qualifications and experience with salary required, to Short Brothers & Harland Limited, Castlereagh Factory, Belfast, quoting Ref. No. E.4. W 3180

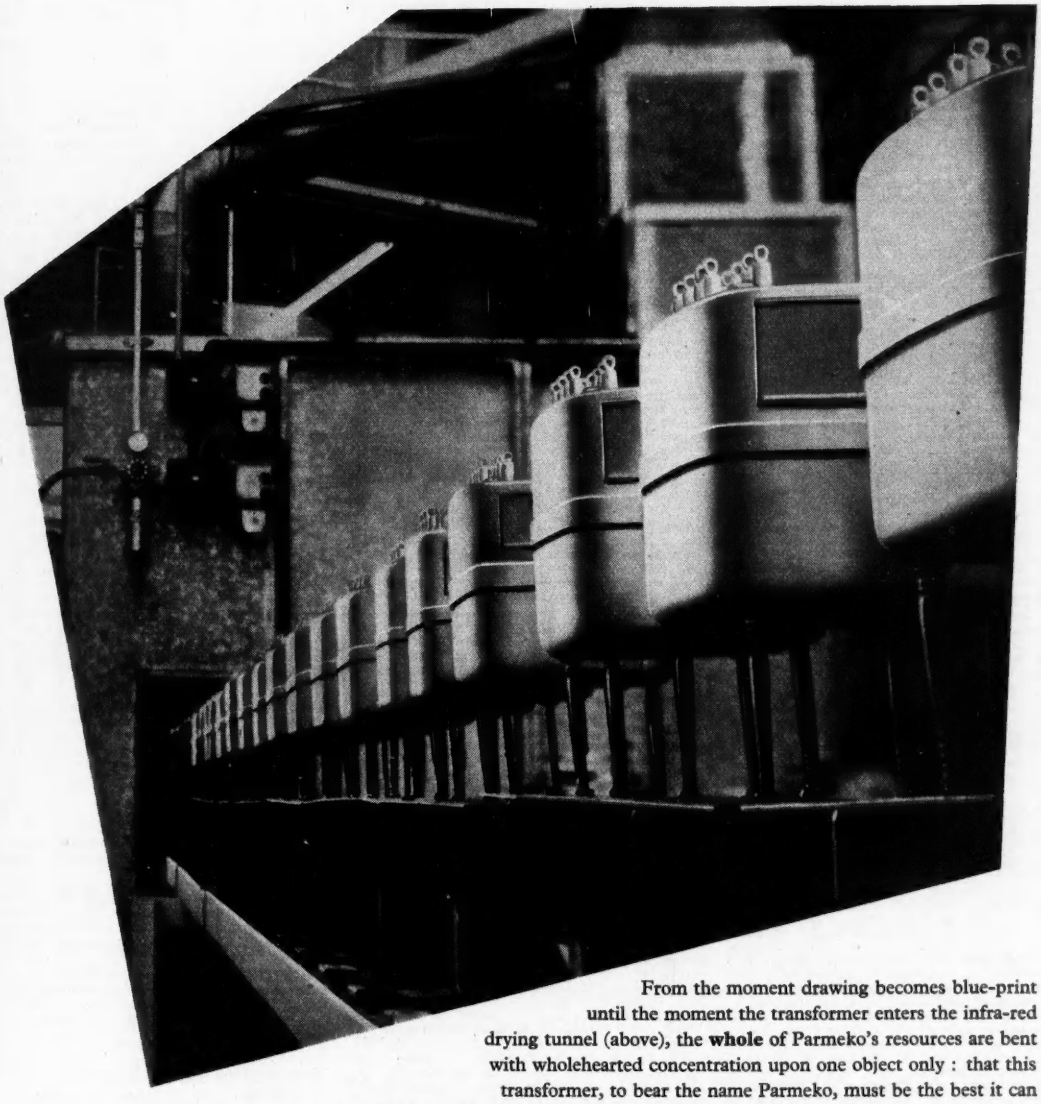
DEVELOPMENT ENGINEERS. Marconi's Wireless Telegraph Co., Ltd., Chelmsford, have vacancies in their Aeronautical Development Group for qualified Engineers to carry out research into and development of airborne communication and navigational aid equipment. Applications (which will be treated as confidential) are invited especially from engineers having design experience of communication receivers, mobile transmitters or small electro-mechanical devices. The positions offered are permanent and pensionable. Good salaries will be offered to suitable applicants, who will be responsible for the particular phase of work on which they are engaged. Please write giving full details and quoting Ref. 875E to Dept. C.P.S., Marconi House, Strand, W.C.2. W 2005

DEVELOPMENT ENGINEER required. Design experience of H.F. and V.H.F. transmitters essential. Good theoretical background and knowledge of production methods desirable. Apply with full details to Personnel Manager, Pye Telecommunications Ltd., Ditton Works, Cambridge. W 1934

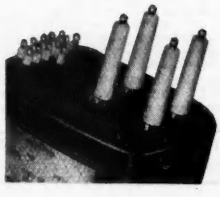
DRAUGHTSMEN experienced in the radio field required for interesting work in connection with the development of aerial systems for aircraft. Write giving full particulars in-

CLASSIFIED ANNOUNCEMENTS
continued on page 6

One Way only . . .



From the moment drawing becomes blue-print until the moment the transformer enters the infra-red drying tunnel (above), the **whole** of Parmeko's resources are bent with wholehearted concentration upon one object only : that this transformer, to bear the name Parmeko, must be the best it can possibly be. To this end there is an unswerving single-mindedness on the part of everyone in the company. There are many men in the organisation who could lend their skill to the production of other products for the electrical and electronic industries but Parmeko insist that they shall be " master of one." How well they succeed is most strikingly shown in the orders that are repeatedly given by some of the largest manufacturers in the world to . . .



The firm with the one-track mind

PARMEKO *of* LEICESTER

MAKERS OF TRANSFORMERS *for the Electronic and Electrical Industries*

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

cluding age and salary required to Personnel Department, Vickers-Armstrongs Ltd., Hursley Park, Nr. Winchester. W 3157

DRAUGHTSMEN experienced in Broadcast Radio and Television are offered exceptional opportunities with a firm of repute in the London area. Experience in production drawing or mechanical design would qualify for a very attractive starting salary. Applications which will be treated in strict confidence, should give full details of experience and should be addressed to Box No. W 3183.

DRAUGHTSMEN required. Electronic Instrument, or radio experience. Salary according to qualifications. Saturday interview, if needed. Opportunity to broaden experience with reputable firm. Near City centre and all amenities. Apply Marconi Instruments Ltd., Longacres, Hatfield Road, St. Albans. W 3195

DRAUGHTSMEN required for design and production of light electro-mechanical apparatus. Varied and interesting work. Previous experience in the radio industry an advantage. Please apply, stating age and full details of past experience to Personnel Manager, Pye Telecommunications Ltd., Ditton Works, Cambridge. W 1935

DRAUGHTSMAN with some experience of electro-mechanical instrument work and preferably electronic drawing required for Research Department, Unilever Limited; located at Port Sunlight. Applications in writing to Employment Manager, Lever Brothers, Port Sunlight Limited, Port Sunlight, Cheshire. W 3162

ELECTRICAL test room assistants required with practical experience in assembling and calibrating precision instruments. Good prospects for men with the required qualities. Apply by letter to Cambridge Instrument Co., Ltd., Sydney Road, Muswell Hill, N.10. W 3059

ELECTRONIC ENGINEERS are invited to apply for the following positions with The English Electric Co., Ltd., Luton, for work on Guided Missiles. (a) Senior Electronic Engineer for field trials of a V.H.F. radio link, with previous experience of H.F. communication equipment. Applicants must be prepared to accept responsibility for equipment trials at locations in the United Kingdom other than Luton. Housing assistance may be given. (b) Senior Radar Engineers for work on radar equipment covering a broad field. A good theoretical knowledge and sound practical experience of radar systems is essential. Assistance with housing may be given. (c) Senior Light Current Engineer, Physicists or Mathematicians with an Engineering bias for design and development work on a range of Simulators and analogue computing devices. Responsibilities will include the design and supervision of construction of complete computors. (d) Senior Microwave Engineer for investigation of new methods of construction for miniaturization and weight reduction, design and engineering to the production stage Degree standard and experience essential. The successful applicant may be appointed in charge of a group. Assistance with housing may be given. (e) Electronic Engineer or Physicist to develop equipment and new techniques of ground testing. Applicants should be of Degree or H.N.C. standard with design experience. (f) Senior Eneineers with good fundamental knowledge of Electronics and the ability to apply it to circuit development work. One vacancy exists in a group working on the application of transistors. Assistance with housing may be given. (g) Senior Electronic Engineer for work on Radio and Radar systems design. Applicants should have a good academic background and an inventive turn of mind, with extensive experience. (h) Junior Engineers are also required to assist in all the above work. These positions are permanent and progressive and attractive salaries are offered for able and experienced men. A staff pension scheme is in operation. Applications to Dept. C.P.S., 336/7 Strand, W.C.2, quoting ref. S.A.38. W 2006

ELECTRONIC ENGINEER with University degree required by substantial manufacturer for research and development post offering considerable scope and prospects. Applicants with experience in servo mechanisms, pulse techniques and digital computer principle especially suitable. Birmingham location. Pension scheme. Applications, which will be treated in confidence, should give full details of training and experience, and be addressed to Box No. W 3133.

ELECTRONIC ENGINEERS AND PHYSICISTS are required in experimental work in the field of electronic counting, computing and memory devices. Applicants should have a Degree in Physics or in electrical engineering or hold an appropriate Higher National Certificate. Applicants who have early prospects of obtaining one of these qualifications will be considered if they hold relevant laboratory experience. Apply Mr. G. A. Taylor, Personnel Manager, Mullard Research Laboratories, Cross Oak Lane, Salfords, near Redhill, Surrey. W 3143

ELECTRONIC ENGINEER H.N.C. with design experience, including radio communication work, required for small organization on South Coast. First-class opportunity for keen young engineer for project development. State age, qualifications and salary required. Box No. W 3174.

ELECTRONIC ENGINEERS. Senior and Junior required. Vacancies arise from an expansion of the Company's business which covers a wide field. Applications are particularly welcome from young Graduate Engineers who have had some industrial experience. For the Junior vacancies the minimum technical qualification required in the City & Guilds Certificate in Telecommunications. Applications will be treated in strictest confidence. Near City Centre and all amenities. Saturday interview if required. Apply Marconi Instruments Ltd., Longacres, Hatfield Road, St. Albans. W 3196

ELECTRONIC ENGINEERS with experience, required for responsible positions in connexion with the development of electronic training aids and computing devices. Accommodation available to suitable applicants. Apply in writing to Redifon Limited, Kelvin Way, Crawley, Sussex. W 2009

ELECTRONIC ENGINEERS required by J. Langham Thompson Ltd., 88 High Road, Bushey Heath, Herts. (i) Section Leader with a minimum experience of five years, preferably on government development projects. (ii) A Technical Writer. Apply in writing stating age and experience to Chief Engineer. W 3175

ELECTRONIC INSTRUMENTS LTD., of Richmond, Surrey, has vacancy for Chief Inspector. Applicants must have sound practical experience in testing mechanical and electronic apparatus, together with administrative ability A key post in expanding firm. Application in first instance by letter giving full details of experience and salary. Junior posts also available for electronic engineers, aged 23 upwards, having H.N.C. or equivalent qualifications. W 1973

ELECTRIC & MUSICAL INDUSTRIES LTD., have the following vacancies in their Record Engineering Dept., at Hayes:—(1) Engineer, Graduate or H.N.C. with experience in design and development of recording equipment. (2) Junior Engineers for work in the above field. Applicants should be near completion of or exempt from National Service. Apply in the first instance, giving full particulars of qualifications, training and experience to Personnel Dept. (RL) Electric & Musical Industries Ltd., Hayes, Middlesex. W 2011

ELECTRON MICROSCOPES. Engineer required, preferably graduate in physics or engineering, to operate from London headquarters on installation and regular periodical servicing of electron microscopes in United Kingdom and Western Europe. Applicants must have skilled practical aptitude for electronic and vacuum physics maintenance work and ability to deal with technical inquiries and sales matters in correspondence and personal contact with microscope users. Experience in electron microscopy an asset, but not essential if scientific education and practical electronic background otherwise suitable. State age, and give complete details education, experience, languages, and salary required. Box No. W 3153.

ELECTRON MICROSCOPIST required. Candidate should have a Degree with physics as a subject and be able to operate and adjust an M-V Type EM.3. microscope. Some experience of chemical and bacteriological specimen preparation would be an advantage. Applications giving full details of age, qualifications and experience to Personnel Manager, Boots Pure Drug Co., Ltd., Station Street, Nottingham. W 3185

E.M.I. ENGINEERING DEVELOPMENT LTD., have vacancies in their Hayes and Feltham Laboratories for Senior Electronic Engineers. Applicants should have an Honours Degree in Physics or Engineering, or an equivalent qualification plus about seven years' experience applicable to one of the following:—(a) Design of centimetric radar systems. (b) Design of electro-mechanical servo systems with particular reference to stabilization problems of centimetric aerial systems. (c) Design of service radar equipment. (d) Design of communication equipment particularly in V.H.F. region. All the above posts are exceptionally interesting, carrying very good starting salaries and offering good prospects for the right men. Apply in writing to Personnel Dept. (ED/164), E.M.I. Eng. Dev. Ltd., Hayes, Middlesex. W 3160

E.M.I. ENGINEERING DEVELOPMENT LTD., require Engineers and Physicists for work in connexion with guided weapon development. (a) Circuit Engineers familiar with pulse video and VHF techniques. (b) Circuit Engineers familiar with servo mechanisms, magnetic amplifiers and electronic computing techniques. (c) Engineers experienced in operational research problems associated with complex electronic equipment. Applications are invited for senior, Intermediate and Junior posts for which a good Degree is an essential qualification. Please write in first instance giving full details and salary required to Personnel Dept. (ED/137) E.M.I. Eng. Dev. Ltd., Hayes, Middlesex. W 3161

ENGINEER. aged 26 to 34, required to take charge of Engineering Department of factory manufacturing Quartz Crystals. University Degree and experience of industrial or service electronic equipment essential. Rudimentary knowledge of chemistry an advantage. House could be made available to successful applicant. Write Box WC. 9140 A.K. Advertising, 212a Shaftesbury Avenue, London, W.C.2. W 3149.

ENGINEERS, Mathematicians or Physicists required for design and development work on new projects in the telecommunication field. Experience in this type of work desirable but not essential. Apply, giving full details of age, qualifications, experience and salary required to the Personnel Manager, Standard Telephones and Cables, Corporation Road, Newport. Mon. W 3181

ENGINEER OR PHYSICIST with Degree or equivalent qualification required for interesting development work. Two vacancies exist calling for the following experience:—(a) V.H.F. techniques. (b) Audio frequency circuit design involving feedback amplifiers and filters. Please write with full details to Personnel Dept. (ED/145) E.M.I. Eng. Dev. Ltd., Hayes, Middlesex. W 3159

ENGINEER required to undertake the design of electronic instruments. The successful candidate will be required to accept responsibility for development to the production stage. Degree or equivalent preferred. The salary will be commensurate with qualifications and experience Apply in writing to Advance Components Ltd., Back Road, Shernhall Street, London, E.17. W 1940

ENGINEER required for operational tests and maintenance of airborne electronic equipment. Degree, H.N.C. or equivalent, with some practical experience of electronic equipment desirable. Must be British or Commonwealth subject. Apply: Labour Exchange, Rugby. Ref. Construction Department. The British Thompson-Houston Co., Ltd., Rugby. W 3193

ENGINEERS with development experience of television or V.H.F. techniques required by well-known company in W. London district for work on current television development. Applicants should possess good qualifications, preferably a Degree, or H.N.C., or C. & G. Final Certificate. Please write, in strict confidence, giving full details, age, experience, qualifications and salary desired to Box No. W 1964.

ENGINEER, 25-30 with Degree or H.N.C. in mechanical engineering and experience in the design of servo and hydraulic control systems, is required for interesting development work. Position carries responsibility and scope for future progress in this field. Applicants should write with full details to Personnel Dept. (ED/156), E.M.I. Eng. Dev. Ltd., Hayes, Middlesex. W 3191

CLASSIFIED ANNOUNCEMENTS
continued on page 8

SOLARTRON LABORATORY INSTRUMENTS LTD.

ON STAND 34—PHYSICAL SOCIETY EXHIBITION
8th—13th April

The New Solartron Feedback Voltmeter

VF.252

OUTSTANDING FEATURES:

★ **Absolute Accuracy ±1% of full scale.**

★ **9 sensitivity ranges from 1.5mV-15 volts f.s.d.**

★ **Readings down to 20 microvolts.**

★ **Input impedance greater than 50 megohms.**

★ **Isolated input.**

The Feedback Voltmeter VF.252 sets a new standard of accuracy for valve voltmeters by employing an entirely new feedback technique in the meter stage which eliminates the effects of changes in the forward to backward impedance ratio of the meter rectifiers, resulting in an overall accuracy of ±1% at any setting.

OTHER NEW S.L.I. PRODUCTS ON DISPLAY INCLUDE:

*Low Frequency Decade Oscillator, OS.*104.
*Low Frequency Phase Sensitive Voltmeter VP.*253.
*Calibrating Unit, AT.*203.
Oscilloscope CT. 316 *Model D.*300.
*Power Supply sub-unit, SRS.*154*B.*

SOLARTRON

● *Write for full details of the Solartron range of instruments*

SOLARTRON LABORATORY INSTRUMENTS LIMITED
Solartron Works, Queens Road, Thames Ditton. Tel.: Emberbrook 5611 PBX

SITUATIONS VACANT (Cont'd.)

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

ENGINEER required to undertake the development of transformers and iron cored components. A Degree or equivalent, and some experience of this type of work are desirable. Apply in writing to—Advance Components Ltd., Back Road, Shernhall Street, London, E.17. W 1983

ENGINEER required for the developing of H.F. transmitting equipment. The Applicant filling this post will be responsible for the supervision of projects to the production stage and will work under the general direction of the Senior Engineer. B.Sc. or equivalent essential. Junior Engineers. Duties will include development work on communication equipments in the H.F., V.H.F. and U.H.F. fields. These vacancies will call for men with design experience and with training to Higher National Certificate level. Good working conditions in modern factory with sports, social and canteen facilities. Excellent opportunities for further study. Single board available. Apply to Personnel Manager, Pye Telecommunications Ltd., Ditton Works, Cambridge. W 1941

ERICSSON TELEPHONES LTD., have a number of vacancies in their Research Laboratories in connexion with Electronic Switching and Computing. The posts will carry starting salaries between £600 and £1,000 according to age and experience. (a) Electronic Circuit designers of all grades. Applicants should have Degree or equivalent, and several years' experience in the design of electronic circuits. (Reference L.E./1). (b) Electronic equipment engineers with experience in the layout and mechanical design of electronic instruments and equipment in the radio, radar or communication fields. They will be required to co-operate with the circuit designers in the early stages and may ultimately be responsible for development to the production stage. (Reference LE/2). Applicants who should be British born and between 25 and 35 years of age, should write quoting the reference above and giving details of age, experience, academic or other training, and required starting salary to the Personnel Officer, Ericsson Telephones Ltd., Beeston, Nottingham. W 2751

EXECUTIVE ENGINEER required by Company in West London area, engaged on the development of a wide range of electronic and light mechanical equipments, to take full technical control of a large section of the work. Applicants should have a good Honours Degree and have had first-class experience in a responsible position covering design, development and prototype production. Salary will be commensurate with responsibilities. Please apply with full details to Box No. W 3158.

EXPERIENCED ELECTRONIC Instrument Tester required. Full details to Dawe Istruments Ltd., Harlequin Avenue, Great West Road, Brentford, Middlesex. W 1958

EXPERIENCED Radio Testers and Inspectors required for production of communication and radio apparatus. Also Instrument makers wirers and assemblers for Factory Test apparatus. Apply Personnel Manager, E. K. Cole Ltd., Ekco Works, Malmesbury, Wilts. W 146

EXPERIENCED FAULT-FINDERS wanted by Midland Manufacturers of Radio Equipment. Permanent posts located in the Midlands are offered to men with experience of Radar, Radio control, V.H.F. equipment. Write stating fully, experience and salary required to Personnel Manager Box No. W 3189.

EXPERIENCED MICROWAVE ENGINEERS are invited to apply to Decca Radar Ltd., to join the Company in its extensive work in a wide field of microwave link and radar development. The company offers excellent starting salaries and first rate opportunities for men to exploit their initiative and to rise rapidly to responsible posts. Graduates without industrial experience who are prepared to undertake intensive training are also invited to apply for junior posts. Applicants must be of British nationality. Apply Ref. RLA/14, Decca Radar Ltd., Research Laboratory, 2 Tolworth Rise, Surbiton, Surrey. W 3105

FERRANTI LTD., Edinburgh, have a number of vacancies in their Applications Laboratory in connexion with the development and production of equipment for important new field in industrial control. The work is interesting and offers full scope for initiative. Engineer-Physicists:—For development work involving pulse technique and servo-mechanisms. A Degree or equivalent is essential and previous experience desirable. (Ref. EP/AL) Electronic Engineers:—For work involving the design and testing of electronic equipment for pre-production. A Degree or equivalent is desirable and previous experience essential. (Ref. EE/AL). The appointments are permanent and offer excellent prospects in an expanding organization in Edinburgh. A salary commensurate with the qualifications required for these positions will be paid. Staff Pension Scheme. Apply, giving full details of training, qualifications and experience, and quoting Reference, to the Personnel Officer, Ferranti Limited, Ferry Road, Edinburgh, 5. W 3178

FERRANTI LIMITED, Manchester, have staff vacancies in connexion with long-term development work on an important radio tele-control project at their new laboratories at Wythenshawe, South Manchester. (1) Engineers for research and development work in the following fields: Radar, radio and electronic circuits micro-waves, vacuum and/or high voltage techniques, servo control and electro-mechanical devices and testing equipment associated with the above. Qualifications include a Degree in Physics or Electrical Engineering or Mechanical Science, or equivalent qualifications, and at least two years' previous experience. Salary according to qualifications and experience in the range £500-£1,000 per annum. Please quote reference WE. (2) Technical Assistants for experimental work in the fields listed in (1) above. Qualifications required: a Degree or Higher National Certificate in Electrical or Mechanical Engineering or equivalent qualifications. Salary in the range of £400-£600 according to age and experience. Please quote reference WT. Permanent staff appointments with pension benefits. Application forms from Mr. R. J. Hebbert, Staff Manager, Ferranti Ltd., Hollinwood, Lancs. Please quote appropriate reference. W 2007

FIRST-CLASS OPENINGS for experienced Radio and Television Engineers will shortly become available with a firm of repute in the London area. Engineers able to undertake immediately, development work on broadcast radio and television apparatus would be offered an attractive salary. The successful candidates will be elegible for Company superannuation and insurance schemes. Please reply, giving full details of experience to Box No. W 3184.

G.E.C. STANMORE LABORATORIES invite applications for work on guided missile research from:—1 Experienced Graduates with good Honours Degrees or equivalent qualifications. i. To lead a team working on novel waveguide circuits and ancillary measuring equipment. First class man required, with experience in microwave circuit research and development. This is a senior position of considerable responsibility. (Ref. EE/RCM). ii. Section Leader's post demanding experience of telecommunications with electronics bias. (Ref. EE/SM). iii. Responsible position in transistor circuitry work. (Ref. EE/TWS). iv. For work on:—(a) Microwave components, circuits and/or receivers. (Ref. EE/AGH) (b) Electro mechanical computors must be experienced electronic engineer. (Ref. EE/RHK). (c) Design and development of circuits and/or small servo mechanisms. Age 30-35. (Ref. EE/GAG). 2. Experienced Technicians with pass Degree or H.N.C. for:—i. Devising methods and constructing equipment for valve testing. This post involves some testing of valves under mechanical stress. (Ref. EE/JMCP. 1.) ii. Work on preparation and trials of electronic equipment. Experience with radar or communications equipment essential. Ex-service signals/radar officer or senior N.C.O. might be suitable. (Ref. EE/JMCP. 2.) iii. General circuitry work. ((Ref. EE/WPC. 1.) iv. Work on microwaves and aerials. (Ref. EE/WPC. 2.) v. Testing servo equipment; good circuitry experience essential. (Ref. EE/JRH. 1.) vi. Development and testing of magnetic amplifiers. (Ref. EE/JRH. 2.) 3. Engineer-Designers with Degrees or H.N.C. for:— i. Dynamic machine stressing; only experienced stressman considered; senior position available. (Ref. EE/WG. 1). ii. Design work in drawing office, good practical training essential; senior and junior posts available. (Ref. EE/WG. 2.) Applications should be made in writing to the Staff Manager, G.E.C. Stanmore Laboratories, The Grove, Stanmore Common, Stanmore, Middlesex, stating age, qualifications and experience and quoting the appropriate reference. W 3151

GRADUATE ENGINEER is required to work in the Research Laboratory on the design and development of glass-metal seals and glass envelopes for lamps, valves and semiconductor devices. There are good opportunities for close liaison with glass, lamp and valve factories. Candidates, under 30 years of age, should have a Degree in Engineering or in glass technology. Preferably backed by practical experience. Apply: quoting reference GE. to the Director of Research, The British Thomson-Houston Co., Ltd., Rugby W 3127

G. V. PLANER LTD., Consultants and Development Laboratories, have a senior and junior vacancy for Electronic Engineers or Physicists, to work with Chemists on interesting research projects concerning electronic components and materials, electrical ceramics, etc. Apply: G. V. Planer Ltd., Hanworth Trading Estate, Hampton Road, Feltham, Middlesex (Fel 3399). W 1961

HIGH FREQUENCY HEATING (Induction and Dielectric) technical representative required. Applicants should preferably have had previous experience on the sale of all classes of such equipment. Apply Managing Director, Radio Heaters Ltd., Eastheath Avenue, Wokingham, Berks. W 1965

HIVAC LIMITED, manufacturers of specialized thermionic and electronic devices offer interesting posts for scientists, engineers and technicians in their expanding organisation on research and development projects in valves, cold cathode tubes and transistors. Previous experience in these fields, although an advantage, is not essential, but a sound education and an active and inquiring mind are. Encouragement will be given, wherever possible, to the publication of original work. The company is a member of a major communications Group and the posts, which are available for both senior and junior applicants are pensionable and offer scope for advancement. There is a five-day working week. Applications in writing, which will be treated in strict confidence, stating age, education, qualifications and salary expected, should be addressed to the Engineer-in-Chief, Hivac Limited, Greenhill Crescent, Harrow, Middlesex. W 3070

HONOURS PHYSICS GRADUATE required for work in research laboratory in connexion with factory problems. Experience in electronics, particularly photo-electric devices a distinct advantage. Commencing salary £600-£700 per annum, according to age, experience and qualifications. Non-contributory pension and insurance plan. Scope for advancement. Apply by letter to Personnel Department, Kodak Ltd., Wealdstone, Middlesex, quoting specific vacancy. W 3165

HYSTERISIS MOTORS—Vacancy for first-class electrical engineer with Degree in physics or electrical engineering with experience in the design and development of hysterisis and small high-frequency electric motors: also small electrical mechanisms. Salary £900-£1,000 with pension scheme. Please write in detail, quoting reference G. to Personnel Manager, de Havilland Propellers Ltd., Manor Road, Hatfield, Herts. W 3113

INSTALLATION DESIGN ENGINEERS are required by Decca Radar Ltd., to design protection circuits for prototype radar equipment, and to prepare systems circuit diagrams in collaboration with basic design groups. Applicants must have qualifications to at least full City & Guilds Certificate Standard. The post is permanent and pensionable. British

CLASSIFIED ANNOUNCEMENTS
continued on page 10

Air Sea Rescue?

The "Princess Victoria" was lost just over a year ago and with her, 133 lives. This disaster occurred only 20 miles from land but search aircraft found the location too late because there was no ship-to-air communication. Further tragedies may well be avoided by ships being able to talk direct to each other and to aircraft. The RM.200 V.H.F. transmitter and receiver has been developed to meet this need.

TYPE RM 200 Multi-spot channel marine V.H.F. radio-telephone operating from A.C. Mains and/or Batteries. Amplitude Modulation.

Range: Ship-to-ship 25 miles; Ship-to-air over 100 miles.

Provides communication on the following INTERNATIONAL channels and 8 other channels.

121.5 Mc/s Aircraft Distress & Safety
156.3 Mc/s Marine Intership
156.6 Mc/s Marine Port Control
156.8 Mc/s Marine Safety & Calling

Price £210 Delivery, 4 months

REES MACE MARINE LTD.

. . . . . ONE OF THE PYE GROUP OF COMPANIES

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

nationality essential. Please write, quoting Ref. RLA/20, Decca Radar Ltd., Research Laboratory, 2 Tolworth Rise, Surbiton, Surrey. W 3190

KELVIN & HUGHES LIMITED have vacancies for Senior Draughtsmen at their Research Laboratories at Gt. Dunmow. Applicants should have had several years' experience of Electronic and/or Electro-Mechanical devices but applications will also be considered from design Draughtsmen with good experience in light Mechanical Engineering and some knowledge of Electro-Technology. The work is interesting and varied and would entail carrying a project through from the earliest development to the production stage. Write in confidence stating age, qualifications and experience to Personnel Manager, Kelvin & Hughes Ltd., New North Road, Barkingside, Essex. W 3140

LOUD SPEAKER ENGINEERS (a senior and junior) required by old established and well-known company offering permanent positions with excellent prospects. Applicants should preferably have had experience of speaker design and measurement but for the junior post, experience in a radio laboratory would suffice. Apply in strict confidence (our own personnel have been advised of this advertisement) stating salary required to Box No. W 1984.

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, have vacancies at Chelmsford for experienced Technical Authors, men or women, to prepare handbooks on operation and maintenance of radio and radar equipments. Applicants should have sound technical training and preferably some practical experience in design or development of radio equipment. The appointments carry good salaries and are permanent and pensionable. Please write giving full details of qualifications and experience, and quoting Ref. 278E, to Dept. C.P.S., Marconi House, Strand, W.C.2. W 2004

MESSRS. BARR & STROUD LTD., have the following vacancies in their expanding development laboratories and design department; (a) Development engineers, with experience in one or several of the following fields of electronics: low frequency circuitry, d.c. amplifiers, servo systems, simulators, microwave circuitry, etc. (b) Microwave Physicist or Engineer for work on centimetric waveguide and aerial systems. (c) Engineer to take charge of model and assembly shop laid out for small quantity batch production, inspection, climatic and durability test of new types, batch sampling, etc. (d) Draughtsman experienced in electro-mechanical and electronic equipment design. Apply giving age, experience and qualifications to: The Secretary, Messrs. Barr and Stroud Ltd., Anniesland, Glasgow, W.3. W 3179

METHODS ENGINEERS required for senior positions in expanding manufacturers, S.E. London. Principal duties concern radio and TV line layout: preference given to those with job study experience. To right applicants these will prove permanent and progressive posts with commensurate salaries. Write in confidence, with full particulars and salary required, Box DC. 9449, A.K. Advertising, 212a, Shaftesbury Avenue, London, W.C.2. W 3150.

MULLARD EQUIPMENT LTD., have vacancies in their Engineering Dept., for electronic and electro-mechanical engineers with experience in the development and engineering of communications and other electrical equipment. Permanent position, good salary, and pension scheme. Apply in writing to Personnel Dept., 51/55 Garratt Lane, S.W.18. W 3139

MULLARD RESEARCH LABORATORIES in Surrey have a number of vacancies for Physicists and Electronic Engineers with a good Degree or equivalent qualification for work on a variety of projects including:—(1) Solid Physics and semi-conductors. (2) Magnetic materials and applications. (3) Microwave techniques and particle accelerators. (4) Advanced electronic circuit techniques, including transistor applications. (5) Colour Television. (6) Computors and servo-mechanisms. Some experience in one or more of these fields is desirable, but recent graduates are also invited to apply. Mathematics graduates with experimental leanings are not excluded. Successful applicants will join teams engaged on research and advanced development projects. Publications of original work wherever possible is encouraged. Salaries are based on qualifications, experience and age, and are in keeping with present day levels. General prospects within the organization are excellent. Apply to Personnel Officer, Mullard Research Laboratory, Cross Oak Lane, Salfords, near Redhill, Surrey, quoting reference E.R.L. W3156

MURPHY RADIO LIMITED have vacancies in the Electronics Divison Laboratories for qualified engineers to design and develop the following: 1 V.H.F. and U.H.F. Communications equipment. 2 Airborne and ground radar equipment. 3 Computing devices and servo systems. 4 Nucleonic equipment and measuring instruments. The salary range is £600-£1,100 per annum depending upon experience. Further posts are available to engineers of H.N.C. standard or equivalent having less experience, the salary range being £450 to £650 per annum. Applications giving age, full details of qualifications, experience and salary required, should be forwarded to Personnel Department (E.D.L.), Murphy Radio Limited, Welwyn Garden City, Herts. W 3087

MURPHY RADIO LIMITED wish to appoint Senior Design Engineers to lead teams in their radio and television laboratories. Successful applicants must possess good academic qualifications with some research experience and several years' service in an industrial organization engaged in television or allied fields. The posts are pensionable and the salaries paid will be commensurate with the high standard of qualification required. Applications, which will be treated in strict confidence, should be addressed to the Chief Designer, Murphy Radio Ltd., Welwyn Garden City, Herts. W 3169

McMICHAEL RADIO LTD. require Senior and Junior Engineers in their equipment division laboratory at Slough. Training and experience in the field of applied electronics (including communications) and experience of working with Government Departments are the chief qualifications required. Write stating age and full details of training, qualifications and experience to the Chief Engineer, Equipment Division, McMichael Radio Ltd., Slough, Bucks. W 157

NELSON RESEARCH LABORATORIES, The English Electric Co., Ltd., Stafford, have vacancies in the Test Section for young men with Electronic Workshop Testing experience. The work which is in connexion with Prototype Devices is of a non-repetitive nature. Preference will be given to applicants who hold a City & Guilds Telecommunications Engineering 4th year Certificate or ordinary National Certificate. Apply to Dept. C.P.S., 336/7 Strand, W.C.2, quoting ref. 944B. W 3118

OPPORTUNITY offered to an Electronic Engineer capable of holding a responsible post as an instrument designer. An engineering Degree and experience covering a wide range of frequencies are advantages which will be reflected in the salary offered. Box. No. W. 1939.

PAPER CAPACITOR Development Engineer required by a large Progressive Company for work on Impregnated Paper Dielectrics. Applicants should have considerable practical experience, ability to originate prototypes and assess their market potentialities. Reply, in confidence, stating age, qualifications, summary of experience and salary required to Box No. W 1981.

PRODUCTION MANAGER required for Radio Factory in Southern Rhodesia. Applicants, preferably single, must have several years' experience in the Radio industry in similar capacity, and be capable of production layout, time study and overall technical supervision. Commencing salary £120 per month. Air passage will be provided. Apply in writing to 31 Burlington Avenue, Kew Gardens, Richmond, Surrey. W 1971

PYE TELECOMMUNICATIONS LTD., Ditton Works, Cambridge, will shortly have a limited number of vacancies for Junior Engineers. Experience in V.H.F. design and engineering is essential. Salary according to qualifications and experience. Modern factory. Sports, social and canteen facilities. Single board available. Please apply, stating age, qualifications and experience to Personnel Manager. W 1933

QUALIFIED MECHANICAL ENGINEER required, age not over 35, with some knowledge of radio and electrical engineering and with an aptitude for experimental work to act as second in charge of newly formed Development Department at a factory in the West Midlands. The maximum salary for this post is £1,210 per annum and the starting salary will be calculated according to the qualifications and experience of the successful applicant. W 3152

RADIO AND RADAR TESTERS. First class men required for work on V.H.F. Communication Gear and Government Contracts for Radio and Radar Equipment by Midland Manufacturers. Men with wide experience of Fault Finding in any of the fields mentioned should write giving full details to Box No. W 3188.

REQUIRED for laboratories near Slough of a specialist manufacturing company, a Physicist with a bias towards electricity (not electronics) for interesting research and development work directed principally but not solely towards the electrical industry. Sound general training required, and some laboratory experience, and knowledge of instruments and of electrical contact phenomena would be helpful. Salary about £700 p.a. Box No. W 1959.

REQUIRED in Buckinghamshire. Experienced Assistant (Male) for maintenance of electrical (including electronic and photo-electronic) laboratory equipment. Skilled R.A.F. tradesman considered. Salary £8 to £11, according to age and qualifications. Good working conditions. Reply, giving age, particulars of education and experience to Box No. W 1977.

SENIOR DESIGN DRAUGHTSMAN required by a large engineering company due to expansion of company's services and commercial business. Applicants should have a comprehensive knowledge of mass production of radio, television and services equipment. Salary up to £700 per annum; monthly status. The vacancies are of a permanent and progressive nature. Company superannuation and life assurance scheme in operation. Please reply, giving details of experience to Box No. W 3107.

SENIOR ENGINEERS. Opportunities are offered by a well known London firm of telephone manufacturers to direct the work of groups engaged on research and development in carrier transmission and electronics as applied to telephony. Commencing salaries £800 to £1,200 according to qualifications and experience. Replies to Box No. W 3122.

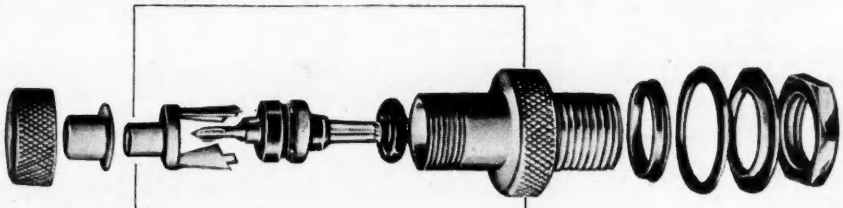
SENIOR ESTIMATORS required by a large and progressive Engineering Company. These vacancies occur owing to normal expansion of Company business. Applicants should have a comprehensive experience of the light electro-mechanical engineering fields, with special emphasis on Ministry Contracts. These are attractive vacancies and call for men with sufficient ability and initiative to justify a salary of up to £850 per annum. All staff privileges, including superannuation and insurance schemes are available to the selected candidates. Applications, which should give full details of qualifications and experience, should be addressed to Box No. W 3145.

TECHNICAL SALESMAN required to sell nucleonic instruments in research, hospital and industrial fields. Electronic background and sales experience vital, together with enthusiasm and drive. Box No. W 1967.

TECHNICAL SALES REPRESENTATIVE with progressive scientific instrument manufacturers. Excellent opportunity for young man with personality and drive. Write giving full details of education, training, experience, pay required etc., to W. G. Pye & Co., Ltd., 'Granta' Works, Cambridge. W 1970

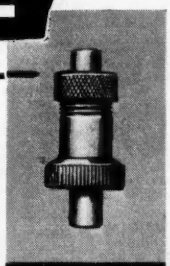
TECHNICAL WRITER required to assist in the preparation of operating instructions and technical bulletins on facsimile equipment, measuring instruments, magslip and servo components Degree or H.N.C. desirable with an aptitude for this specialized form of writing. Apply in

CLASSIFIED ANNOUNCEMENTS
continued on page 12



MINIATURE

CO-AXIAL SEALED PLUGS AND SOCKETS



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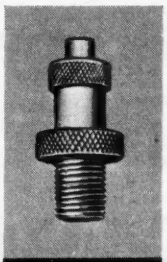

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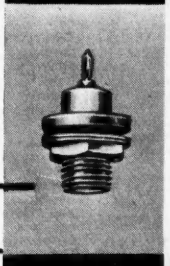

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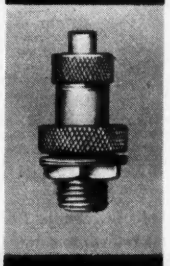

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SITUATIONS VACANT (Cont'd.)

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

writing to Muirhead & Co., Ltd., Beckenham, Kent. W 3132

TELEVISION ENGINEERS required for Demonstration Installation Unit (T.V. Transmission Equipment). Must be willing to travel overseas. Apply by letter in first instance to: Engineer in Charge, Demonstration and Installation Section, Pye Ltd., Cambridge. W 2008

TEST ENGINEERS required for interesting work in connexion with Radar and other Electronic Equipment. Applicants must have sound theoretical knowledge of radar backed by some practical experienced gained in H.M. Forces or industry. Good wages and excellent conditions. Single lodging accommodation available. Apply giving full details to Personnel Dept. (CE/4) E.M.I. Ltd, Hayes, Middlesex. W 3131

THE ADVERTISERS, an established firm manufacturing Quartz Crystals, N.W. area, require the services of a Crystal Engineer to take charge of pre-production department. Experience of development and production essential. Permanent post, excellent contributory pension fund. Write giving full details, in confidence, to Box No. W 1957.

THE BRITISH TABULATING MACHINE CO., LTD., manufacturers of "Hollerith" accounting machines will shortly open a new Research Laboratory at Stevenage, Herts. Men interested in the development of electronic digital computing techniques for business accounting machines, and who are seeking employment of this nature in congenial surroundings, are invited to contact the Company with a view to a Staff Appointment. Experience of photo-cell circuitry and counting techniques desirable but not essential. In particular, the Company would like to interview (1) University Graduates with an Honours Degree in Physics or Electrical Engineering, some previous experience in the electronic research and development field being an advantage. (2) Engineers holding a Pass Degree or Higher National Certificate, or equivalent qualifications. Practical experience of electronic equipment an advantage. Salaries will be commensurate with experience and qualifications. A Pension Scheme is in operation. Applications giving full particulars of candidate should be addressed to Personnel Officer, British Tabulating Machine Co., Ltd., Letchworth, Herts. W 1972

THE DECCA NAVIGATOR COMPANY LTD. have immediate vacancies for Junior and Senior Electronic Engineers to work on the development of navigational equipment in new laboratories at New Malden. The posts will carry starting salaries in the range of £600 to £1,000 according to age and experience and are permanent and pensionable. Applicants who must be of British nationality should have a sound technical education, preferably to Degree standard. Previous development experience essential. Write giving full details of age and education, qualifications and experience to the Personnel Officer, Decca Navigational Co., Ltd., Shannon Corner, 7 Beverley Way, New Malden, Surrey. All applications will be treated in the strictest confidence. W 3155

THE GENERAL ELECTRIC CO. LTD., Brown's Lane, Coventry, require Senior and Junior Electronic Development Engineers for work on Guided Weapons and like projects, particularly in the field of Microwave and Pulse Applications. Mechanical Development Engineers, Designer Draughtsmen and Draughtsmen, preferably with experience of Radar type equipments, also required for the above projects. Salary according to age, qualifications and experience. Apply by letter stating age and experience to the Personnel Manager (Ref. R.G.). W 169

THE PLESSEY COMPANY have vacancies at their Ilford works for engineers and draughtsmen of senior and intermediate grades for development work on components and mechanisms for Radio, Television and Communications equipment. These vacancies occur as a result of the enlargement of the laboratories to permit a substantially increased interest in the design of circuits and components for specific applications. All positions are permanent and pensionable and the expansion now in progress offers good prospects of advancement. Salaries are progressive and attractive initial salaries are offered to men who are qualified by reason of educational attainment or practical experience. All applications will be dealt with in confidence and should be addressed, in the first instance, for the attention of the Personnel Manager, The Plessey Co., Ltd., Vicarage Lane, Ilford, Essex. W 3144

THE RESEARCH LABORATORIES of the General Electric Company are establishing an organization near Adelaide, South Australia, for trials and further development of guided weapon equipment, which is at present under development in this country. Applications are invited from Graduates with suitable qualifications to fill the following vacancies:— (a) An Engineer to take charge of trials teams. (b) An Engineer or Physicist to take charge of a Laboratory engaged on the development and use of special test equipment. Candidates for post (a) and (b) should have had experience of modern radar or similar equipment, and of supervising the work of a small number of experimental staff; these are responsible posts offering opportunities for the exercise of initiative and independent judgment in both technical and administrative matters. The successful applicants will receive training in England on the work they will be doing ultimately in Australia and will be transferred to that country in due course. Details of conditions of employment, housing, passages to Australia, etc., will be given to candidates when interviewed. Reply quoting Ref. EE/AUST to the Staff Manager, GEC, Stanmore Laboratories, The Grove, Stanmore Common, Stanmore, Middlesex, stating age, qualifications and experience. W 2018

TIME AND MOTION STUDY ENGINEERS required by a large and expanding engineering company engaged in the manufacture of electronic and associated equipment. Applicants should have training in effort rating and in the practical application in time and motion study in the machine shops and line assembly. The position carries all normal staff privileges and offers ample scope for advancement. Kindly state full particulars of experience, age, salary required to Box No. W 3187.

TRANSFORMER DESIGNER required for development projects involving audio-frequency power transformers, pulse transformers, oil-filled units, etc. Apply stating age, qualifications and experience to the Personnel Manager (Ref. R.G.), The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. W 192

UNILEVER LIMITED require a young Engineer or Physicist as technical assistant in their Patents Department. Applicants shoud be of Degree standard and preferably have had some industrial experience. Knowledge of French and German desirable. Applications, giving age and full particulars of qualifications and experience to be addressed to: Personnel Division (KAB 60), Unilever Ltd., Unilever House, Blackfriars, London, E.C.4. W 2017

WANTED LABORATORY ASSISTANT, Ordinary National Certificate standard for Television and Radio Coil Factory. Forty-four hour, five-day week. Salary in accordance with experience. Apply to Miss K. S. Cowan, Personnel Officer, Mitcham Works Ltd., Winchelsea Road, Harlesden, N.W.10. W 194

WRIGHT & WEAIRE LTD., have vacancies for senior and junior engineers for research and development work on components electronic circuitry and small electro/mechanical assemblies with particular reference to magnetic recording. Write in the first instance to the Technical Director, Simonside Works, South Shields, Co. Durham. W 3146

SITUATIONS WANTED

ASSOC. BRIT. I.R.E., 31, seeks position where integrity, personality, organizing ability, good experience and knowledge of electronic development and production methods will be appreciated. Surrey area. Box No. W 1968.

CHIEF MECHANICAL ENGINEER, M.I.P.E., M.I.B.E., M.S.I.A. Senior executive leading Radio and Television manufacturers, now responsible Original Project Design and Development, Styling, Drawing Office, Production Engineering, Jig and Tool Design, Methods, Plant, Tool Room, Machine and Assembly Shops, Inspection, etc. Age 44. Box No. W 1974

ELECTRONIC ENGINEER B.Sc. (Eng), age 32, experience in circuit development and communications field, proficient in several languages desires appointment in sales department of progressive firm. Box No. W 1978.

ELECTRONIC ENGINEER, 37 years, B.Sc. Eng., 15-years' experience in Services, Government Research Establishment, Radio and Aircraft (GW) Industries, seeks position of interest and responsibility. Box No. W 1986.

SERVICE

PERSPEX industrial safety guards. Exhibition and display fittings, shop facia letters. Commercial, display and advertising signs, engraved, embossed and silkscreen printed in Perspex, P.V.C., etc. Olympic Plastics Ltd., Wembley Park, Middlesex. Wem. 7933. W 1955

STABILIZED POWER UNITS 150-500v, 30 or 100w. Unstabilized 100-750v. Design, wiring or assembly of electronic equipment. Plastic castings single or repetition. Newtown Industries, Lymington, Hants. W 1966

TRANSLATION of German literature and Publications including drawings and diagrams. Send particulars and ask for quotations. Box No. W 1956.

FOR SALE

CABLE/FLEX, much cheaper in odd length coils. Short lengths supplied. Lists BDC, 591, Green Lanes, London, N.8. W 1962

DUAL ELECTRONIC COUNTERS in metal case with bakelite top and glass front, two sections each 9999 for 24 volts D.C., 45s. post free. Leslie Dixon Co., 214 Queenstown Road, London, S.W.8. W 3176

MAGSLIPS at 1/10th to 1/20th of List Prices. Huge stocks. Please state requirements. K. Logan, Grove Road, Hitchin 1744, Herts. W 183

METALWORK. All types cabinets, chassis, racks, etc., to your own specifications. Philpott's Metal Works Ltd. (G4BI), Chapman Street, Loughborough. W 2000

SINE-COSINE RESOLVERS (3" Magslip Transmitters No. 5, AP 10861). Brand new, each in maker's tin. Offered in quantity at less than one tenth of cost. Export inquiries invited. P. B. Crawshay, 166 Pixmore Way, Letchworth, Herts. W 153

WEBB'S 1948 Radio Map of the World, new multi-colour printing with up-to-date call signs and fresh information, on heavy art paper 4s. 6d., post 6d. On linen on roller 11s. 6d., post 9d. W 102

TENDERS

KARACHI PORT TRUST (Engineering Department) Tender Notice. Quotations are invited for the supply, delivery, installation and maintenance for three years of:—Radio, Inter-Communication Equipment. This equipment must be of the Duplex Standard type and of substantial construction, capable of receiving and transmitting messages to a maximum range of 15 miles and to consist of:—(a) One Control fixed Station at Manora. (b) One fixed Station at Kesmari. (c) Five mobile stations for K.P.T. Floating Crafts. Specifications and Tender forms together with conditions of contract may be obtained by firms tendering from the Consulting Engineers to the Karachi Port Trust, Messrs. Rendel, Palmer & Tritton, 125 Victoria Street, Westminster, S.W.1, England, on payment of a non-refundable sum of One Pound Sterling. Quotations in sealed covers addressed to the Chief Engineer, Karachi Post Trust, Karachi, Pakistan, and subscribed "Quotations for Radio-Inter-communication Equipment" should reach the office of the Chief Engineer in Karachi not later than noon of 21st April 1954, and to remain open for acceptance until 20th October, 1954. The Chief Engineer does not bind himself to accept the lowest or any tender and reserves the right to reject any tender without assigning any reasons. W 3197

EDUCATIONAL

CITY & GUILDS (Electrical, etc.) on "No Pass—No Fee" terms. Over 95 per cent successes. For full details of modern courses in all branches of Electrical Technology send for our 144-page handbook—Free and post free. B.I.E.T. (Dept. 337C). 29 Wright's Lane, London, W.8. W 142

Classified Announcements continued on page 14

another addition to the

SERVOMEX

range of

electrical control instruments

MOTOR CONTROLLER

TYPE M.C.31

a laboratory tool of the highest precision

ABRIDGED SPECIFICATION :

SPEED	0—6,000 r.p.m. in both directions, in five ranges.
TORQUE	21 ounce inches over the whole range of speeds.
STABILITY	At constant torque, but with mains voltage changes up to 10%, the drift of speed is of the order of 1 r.p.m. over an 8 hour test.
REGULATION	From no load to full torque—6 r.p.m.
TACHOMETER	The built-in tachometer covers 0—6,000 r.p.m. in five ranges, with an accuracy of 1%.
BANDWIDTH	Roughly 12 cycles/second over the linear regime. With the amplifier saturating, the peal acceleration is 9,000 r.p.m. per second.

It will be seen that the stability of the M.C. 31 compares favourably with a synchronous motor under present day supply conditions.

Please write for data sheet.

SERVOMEX CONTROLS LTD

Servomex Controls Ltd., Crowborough Hill, Jarvis Brook, Sussex. *Phone: Crowborough 1247*

COUNTY BOROUGH OF BOLTON—Education Committee. Bolton Technical College. Full-time course in Electronic Engineering. A three-year full-time course in Electronic Engineering is now available. Applicants should be between 16 and 18, and have taken, or be taking, General Certificate at the Ordinary Level in Mathematics or Physics, or equivalent courses in technical institutions. This rapidly developing industry offers new and attractive openings to qualified men. Application forms and particulars may be obtained from the Principal, Technical College, Bolton, Lancashire. W 3167

FREE Brochure giving details of courses in Electrical Engineering and Electronics, covering A.M.Brit.I.R.E., City and Guilds, etc. Train with the Postal Training College operated by an Industrial Organisation. Moderate fees. E.M.I. Institutes, Postal Division, Dept. EE/29, 43, Grove Park Road, London, W.4. W 190

ROYAL TECHNICAL COLLEGE, SALFORD. Principal P. F. R. Venables, B.Sc., Ph.D., F.R.I.C., Department of Pure and Applied Physics. A short Post Graduate Course on Semi-Conductors will be held on Friday, 21st May and Saturday, 22nd May, 1954. Lecturers. Professor F. A. Vick, O.B.E., Ph.D., F.Inst.P., H. J. Clark, B.A., J. A. F. Cormick, B.A., A.Inst.P., W. Needham, M.Sc., M.I.E.E., F.Inst.P., H. V. Shurmer, M.Sc., Ph.D., D. D. Jones, M.Sc., D.I.C., D. A. Wright, M.Sc., F.R.A.S., F.Inst.P. Fee for the course £1 10s. 6d. Forms of application, giving brief details of the lectures may be obtained from the Head of Department, W. G. Darvell, M.Sc., F.Inst.P., Royal Technical College, Salford. H. H. Thomson, Clerk to the Governors. W 1976

THE COLLEGE OF AERONAUTICS. The Board of Entry of the College invites applications from suitable candidates for the two-year course which begins in October, 1954, and ends in June, 1956. Candidates should be of graduate standard, although the possession of a Degree is not essential; a good Higher National Certificate is an acceptable standard. The college, a post graduate institution, is devoted to the study of aeronautical science and engineering. The curriculum covers the five main subjects of Aerodynamics, Aircraft Design, Aircraft Electrical Engineering, Aircraft Propulsion and Aircraft Economics and Production. Instruction in the first year is designed to provide students with a broad background of knowledge in all these subjects, with opportunity for limited specialization in two or three of them. In the second year students specialise more particularly, usually in one subject. Experiments in the air are an important part of the work, both in the first year when all students take part in them and in the second year when they are linked to the specialist work of the departments. Students who satisfactorily complete the course will receive the Diploma of the College. Further particulars and details of the procedure for application may be obtained from: The Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks. W 3090

THE UNIVERSITY OF SOUTHAMPTON. Scholarship in Electronics. Applications are invited for a joint Post graduate course in Electronics at the University of Southampton and at Vickers-Armstrongs Ltd., Weybridge. The graduate selected will attend the Diploma course in Electronics at the University during the first year, and will spend the second year training in special projects in the Electronics Laboratory of the firm. The value of the scholarship will be that appertaining to the firm's graduate training scheme, approximately £400 p.a. Applications should be made to the Professor of Electronics, University of Southampton. W 3154

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UNIVERSITY OF EDINBURGH. Principal Sir Edward Appleton, G.B.E., K.C.B., D.Sc., F.R.S. Diploma in Electronics and Radio. The one year post-graduate diploma course in Electronics and Radio will commence on October 12th, 1954, and will provide specialized training for those wishing to proceed to research in this field, or to employment in industrial organizations. Applicants should hold an Honours Degree in electrical engineering, mathematics or physics. The main lecture courses are in network theory, principles of valve circuits, transmission and radiation theory, and particles in fields. Laboratory and field work will be arranged to support the lecture courses. A limited number of grants may be made available for suitable candidates. Further particulars and applications forms can be obtained from the undersigned. Closing date for applications, June 1st. Charles H. Stewart, Secretary to the University. W 3192

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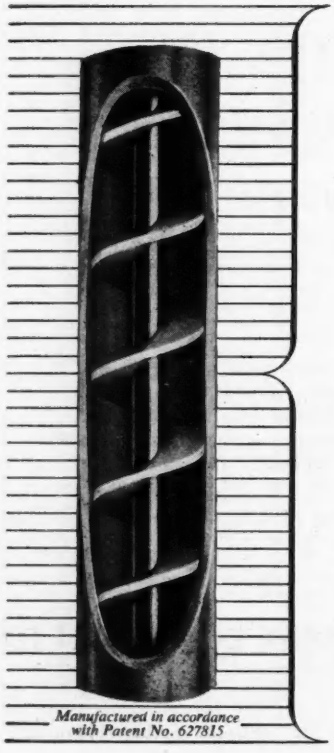

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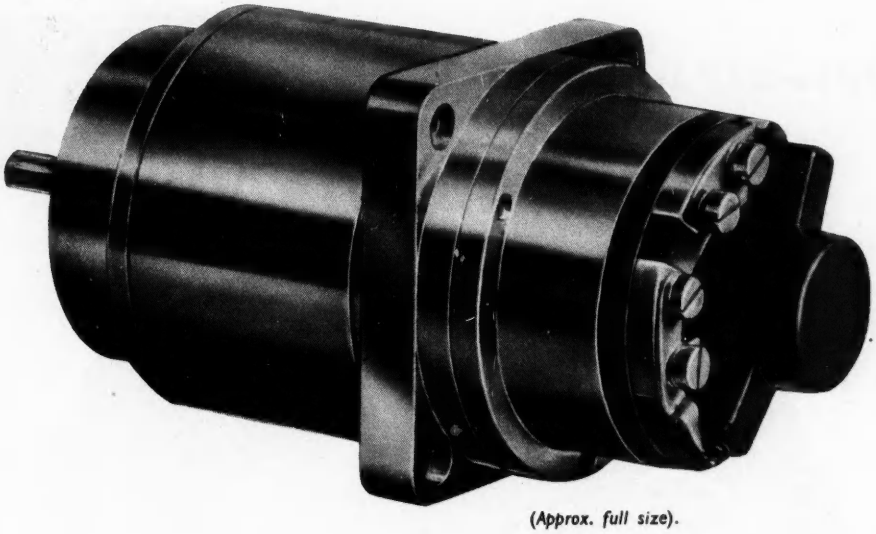

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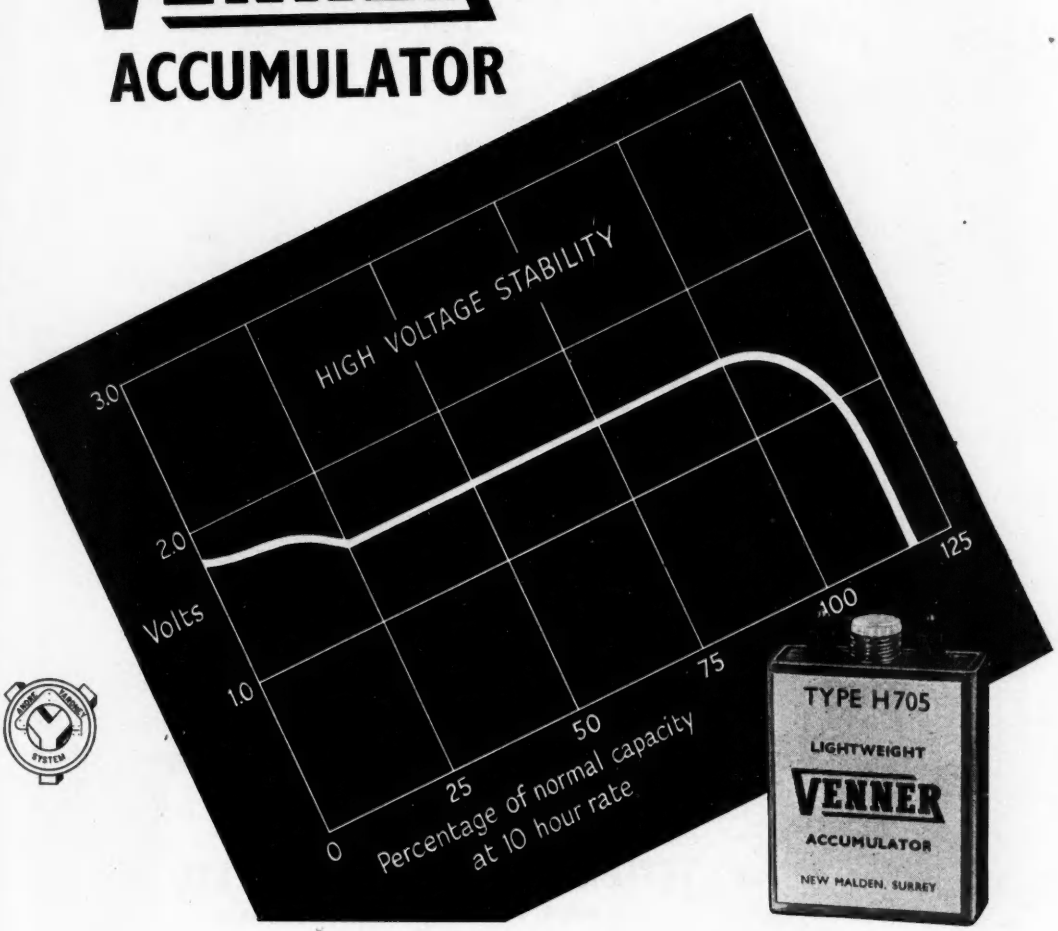

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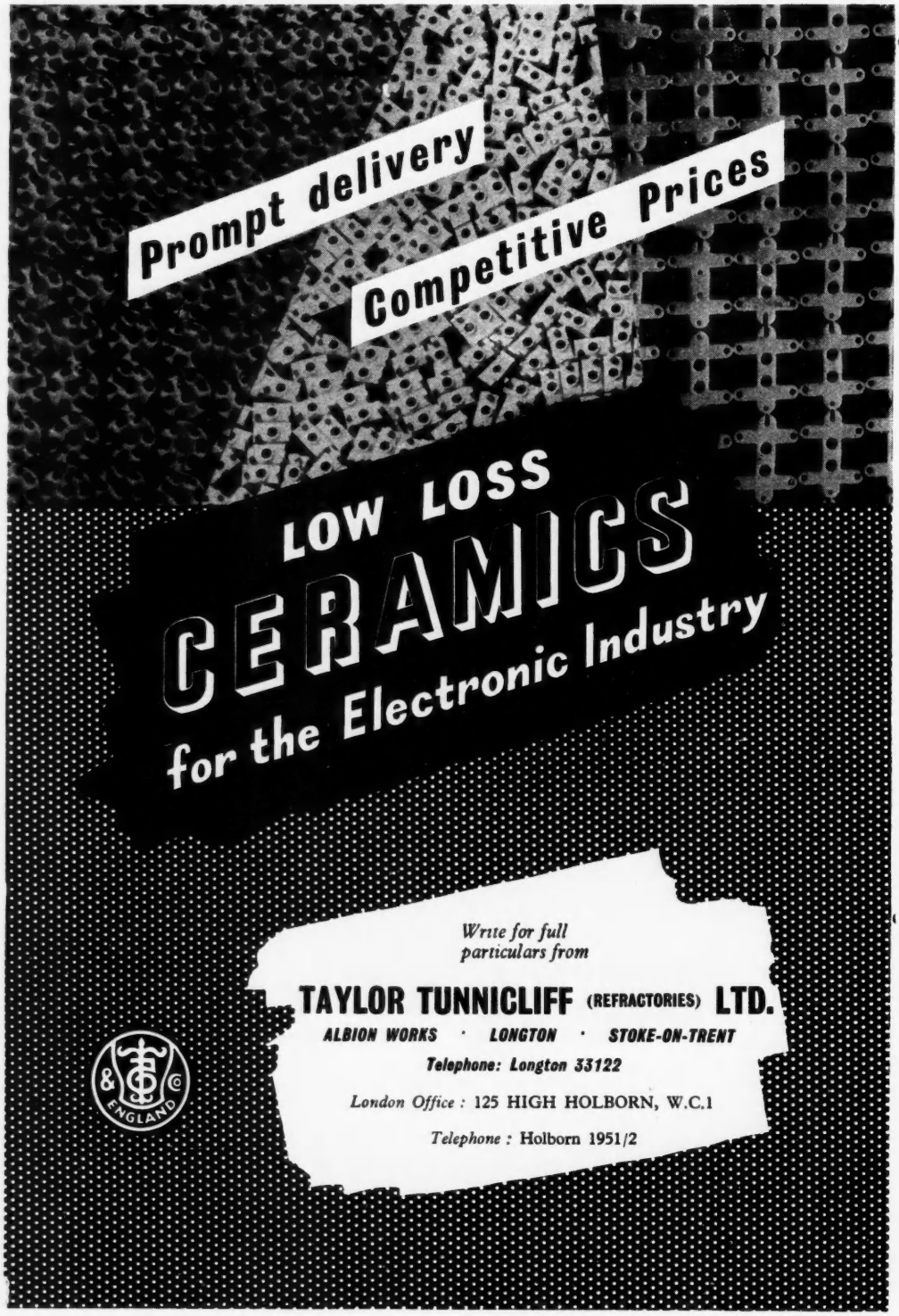
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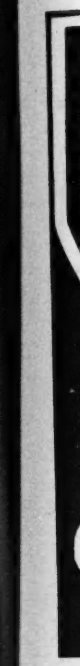

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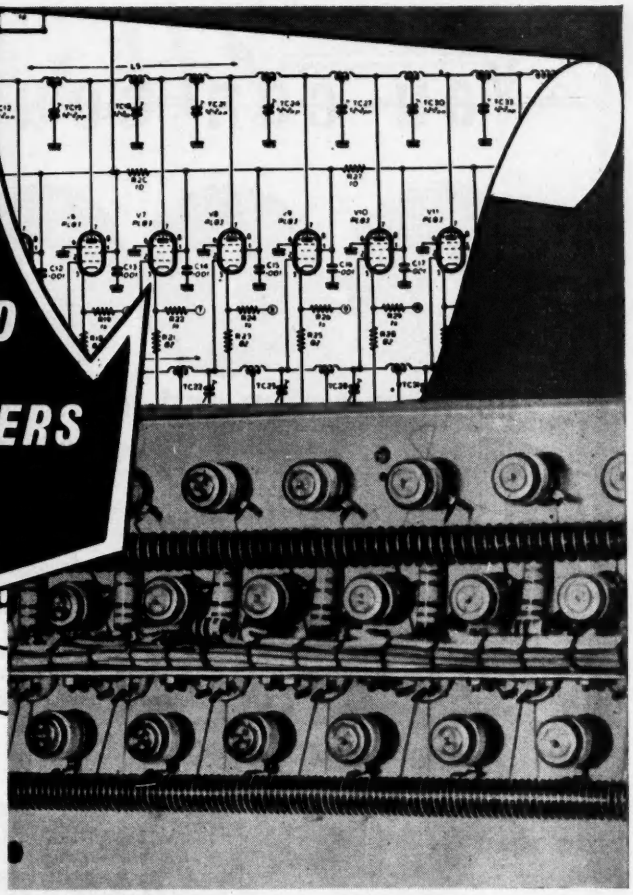

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Transient Response	< .01 microseconds
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Max. Output	150 volts peak to peak

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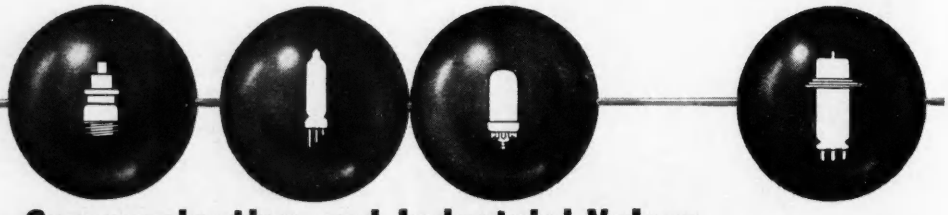

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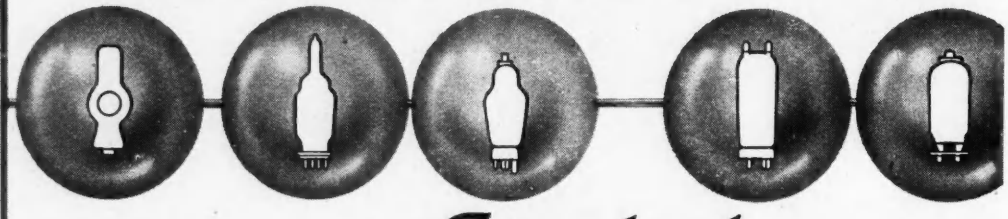

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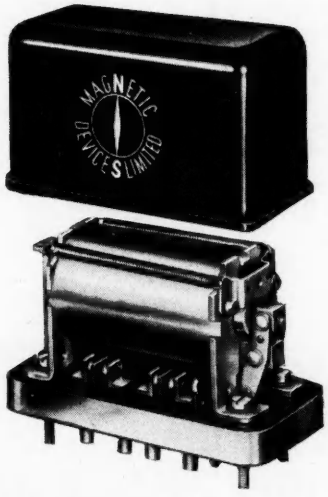

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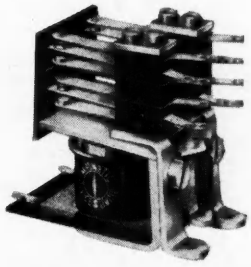

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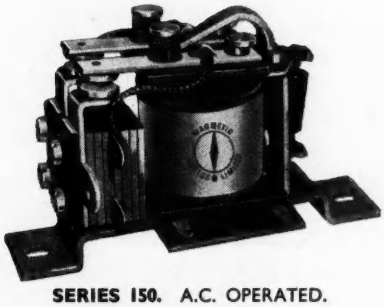

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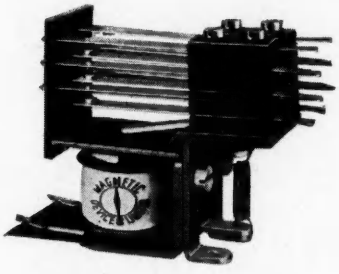

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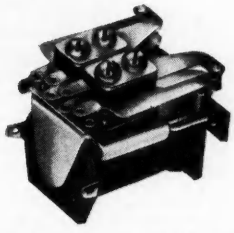

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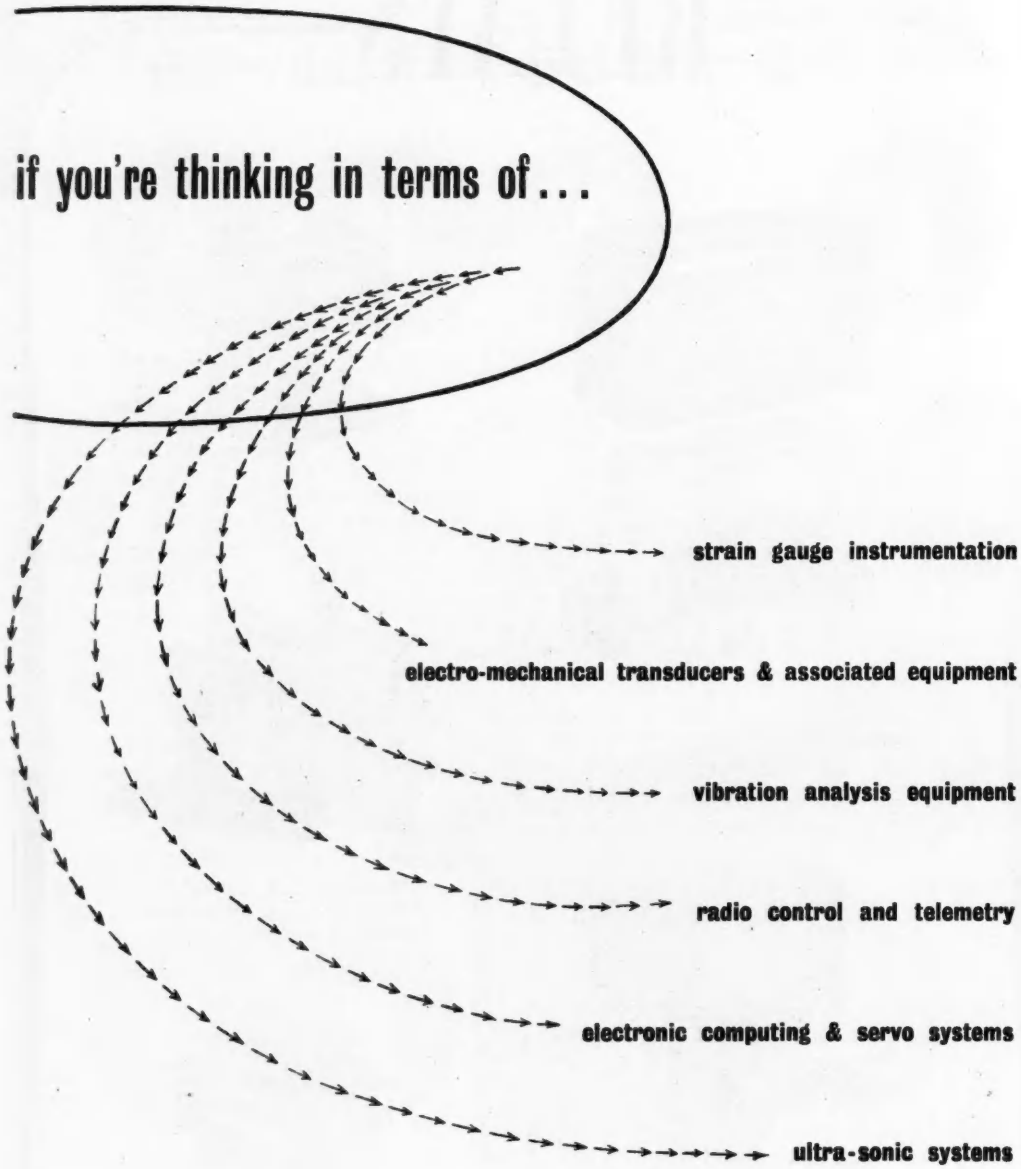
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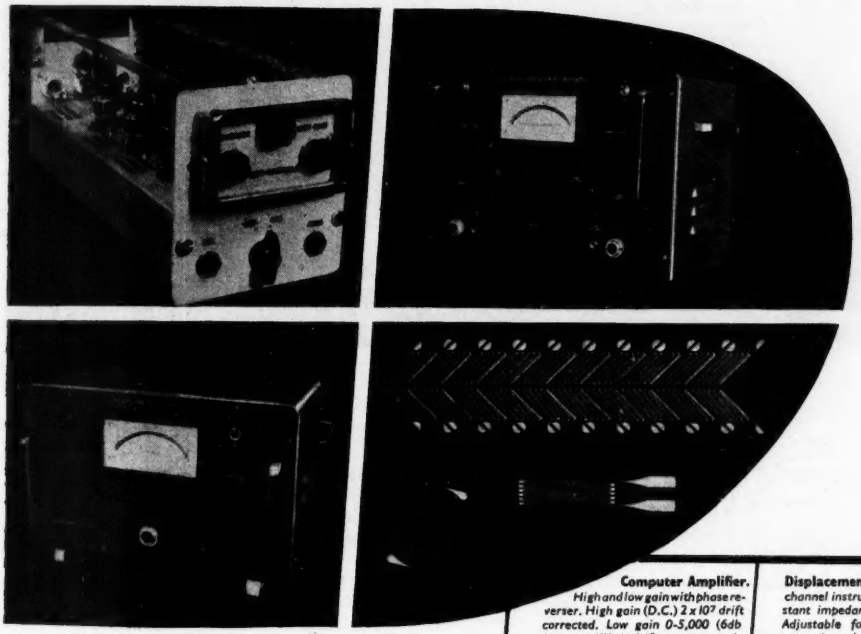

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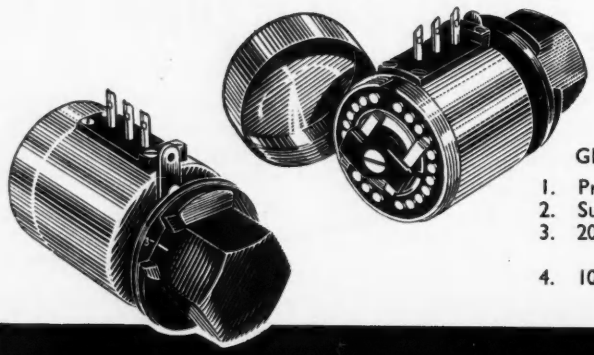

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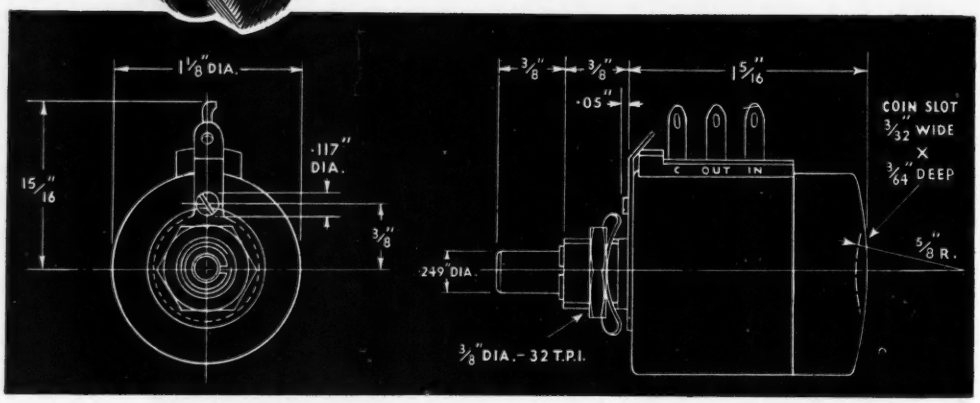

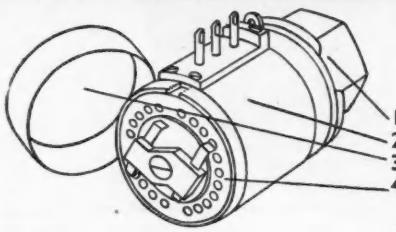

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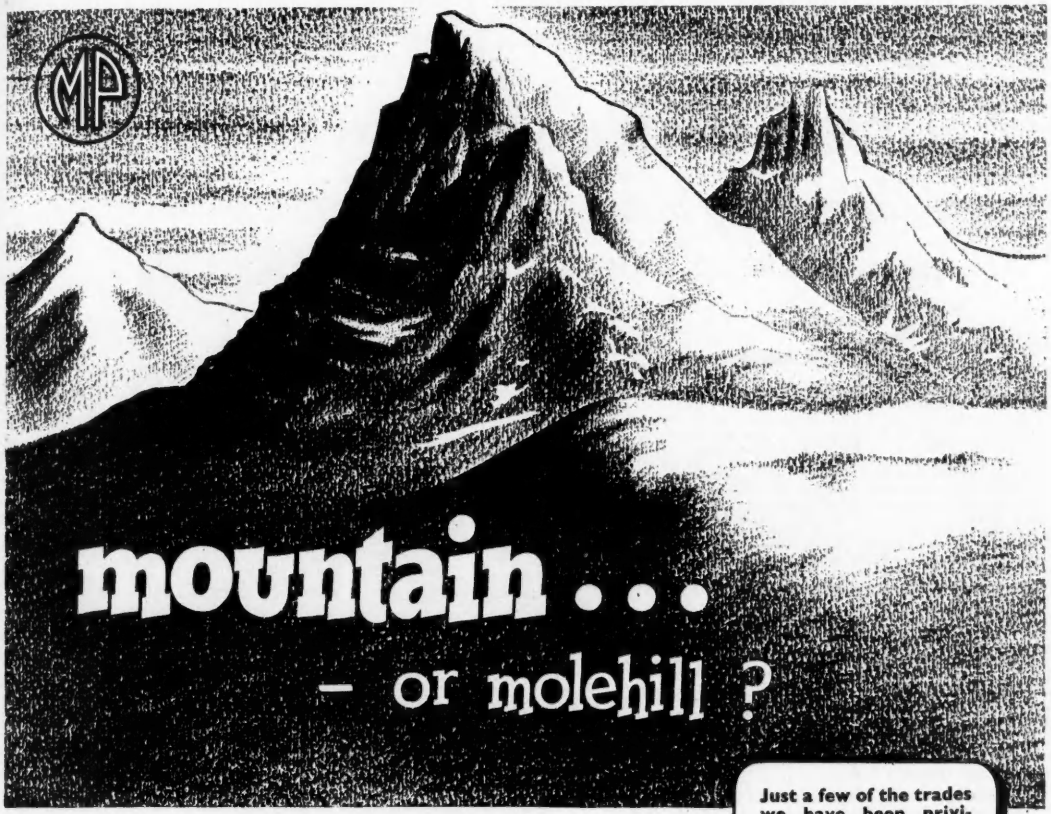

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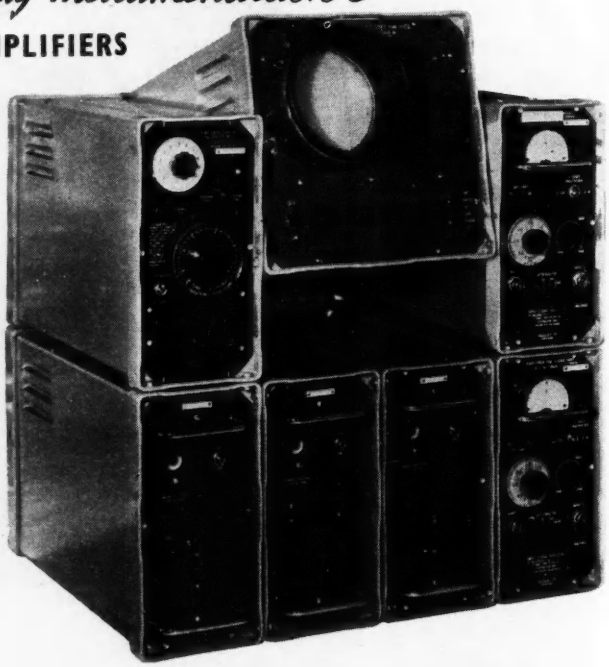

As the name " UNITEL " implies, this system is a conception based on the use of a unit instrument housed in a case of modular dimensions, so that a number of such instruments may be built together, much like bricks in a wall. Each unit case is provided with holes arranged in such a way that it can be attached to a neighbouring case by bolts. In this way an assembly of co-operating instrument units occupying the minimum space can be built up in a flexible but sound engineering manner. Although the dimensions are arranged so that such assemblies may be mounted in standard 19 in. racks if desired, it becomes apparent that there is *no need for the rack*, since the assembly, once bolted together, is self-supporting, and yet any unit can be removed without disturbing the others.

There are also advantages, apart from saving the cost of a rack support, for example :—

VENTILATION & SCREENING

The design of the frame members of each unit case is such that, when bolted together, there is a free air circulation space all round each case, while the ventilation louvres for cooling each unit are arranged in such fashion that they cannot feed hot air from one unit into the cool air entry point of another unit. Magnetic and electro-static screening of each unit is complete owing to the presence of two thicknesses of metal casing and an air space between each pair of cases.

DISPLAY UNITS

There are two models, one giving a single beam display and the other a double gun display on a six inch flat faced screen. Each C.R.T. Unit contains a power supply, and direct access to all deflection plates and the grid of the C.R.T. is provided at the rear of the case. The unit being thus self-contained, it can be used as a separate instrument, for multiple displays, or duplicated for monitoring purposes.

The NAGARD Single Shot Camera will fit the C.R.T. Unit. As illustrated, the unit can be tilted to a convenient viewing angle by use of the case bolt holes.

SERVICING & RELIABILITY

The working chassis of each unit is withdrawable by releasing the front panel screws, the case frame remaining in situ, so preserving the assembly intact.

VERSATILITY

There already exists a good variety of unit instruments each designed to co-operate in feeding various types of potentials to the basic C.R.T. Display Unit.

A feature of this type of instrumentation is that of being able to add new units of differing performance as and when required to deal with specific problems, and also the ability to restore the original system or to modify its spacial arrangement.

A floor mounting trolley platform capable of supporting assemblies of Unitel cased instruments is available so as to give the mobility required under certain laboratory conditions.

All inter-unit power and signal output leads are arranged at the rear of the cases, while all input signal leads enter at the front panels, except those feeding the deflection system of the C.R.T.

DIMENSIONS

There are at present three standard Unitel cases. No. 1, 5¾" x 11½" x 18½". No. 2, 11½" x 11½" x 18½". No. 3, 11½" x 17½" x 18½".

Some of the instruments available in one or more of the above are listed herein, and the best coupling arrangements will be indicated upon enquiry for a particular combination of units intended to provide specific oscilloscopic requirements.

New units are continuously being developed in response to specific requirements. As and when available these will further extend the possibilities of a Nagard-Unitel installation.

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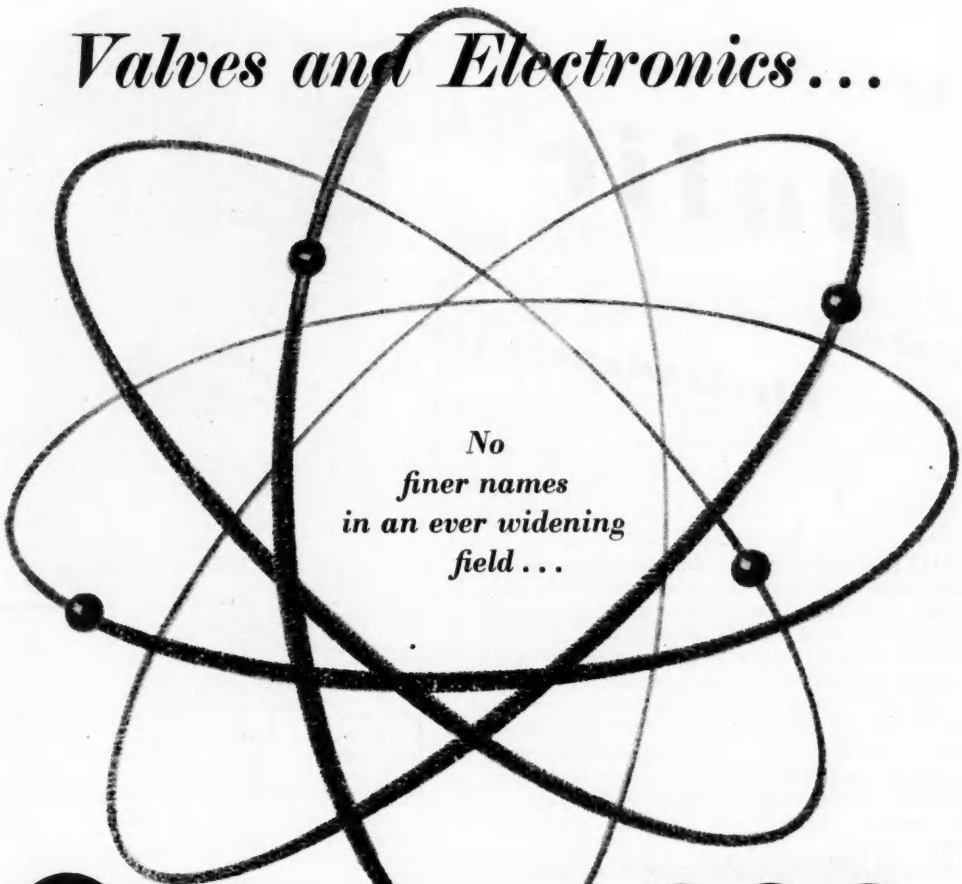
Cathode Ray Display	1001	Single Beam 5" C.R.T. and power supply.
	1002	Double Beam 6" C.R.T. and power supply.
Time Bases	3006	Single Beam 20 msec. −0.2 μsec. +X amp.
	3007	Double Beam 20 msec. −0.2 μsec. + X amp.
	3009	Double Beam 0.2 sec. −2 μsec. + X amp.
	3010	Single Beam 0.2 sec. −2 μsec. + X amp.
D.C. Amplifiers	2201	Pulse Amplifier 0-25 Mc/s. 0.02 rise and delay line 0.3 μsec. included.
	2602	0-10 Mc/s Pulse Amplifier 0.04 rise.
	2603	0-10 Mc/s Sine Wave Amplifier.
	1102	0-2 Mc/s 10,000 gain.
	1202	0-1 Mc/s 20,000 gain.
	1302	0-100 Kc/s 100,000 gain.
	1303	0-100 Kc/s 100,000 gain 1,000 v output.
	2101	0-250 Kc/s Double Channel 3,000 gain.
	2102	0-100 Kc/s Double Channel 100,000 gain.
	2701	High Discrimination Pre-Amplifier x 20 or x 100.
	2502	Single Channel Electrometer input 10,000 Megohms.
Delay Line	2901	0.25 μsec.
Single Shot Camera	2415	f/1.5 lens and connecting hood.
	2445	f/4.5 lens and connecting hood.
Trolley	1403	For 3- or 4-case assemblies of the above.

Valves and Electronics...



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Transmitting Valves and
Industrial Valves

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Cathode Ray Tubes
Miniature Neon Indicators
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THE GENERAL ELECTRIC COMPANY LIMITED. MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

The Dalic Process of Electrodeposition

Renovating the zinc protective coating of a propeller blade on site at Air France.

The DALIC PROCESS of Electrodeposition provides a wide range of coatings on to most basis materials, including aluminium. It is particularly suitable for plating selected areas without stopping-off, for on-site work, and for plating assemblies or components which may not be immersed in plating solutions.

For such non-decorative purposes as building-up worn or overmachined parts, the extremely high speed of deposition and the accuracy with which deposit thickness can be controlled are most attractive features. Deposits are characterised by low stress, extremely fine grain, perfect adhesion and complete absence of porosity.

The DALIC PROCESS has received overwhelming acceptance by industry and recent installations have been made in the electronics, motor car, radio and television and armaments industries, in the Ministry of Supply, and in various research establishments.

Characteristics of Dalic Deposits

Deposit	Maximum Current density (amp./sq. ft.)	Brinell hardness of deposits	Time to deposit 0.0001 in.* (sec.)
Bismuth	1,250	50	7.6
Cadmium	6,000	40	2.5
Chromium	4,000	600	63
Cobalt	1,500	250	7.6
Copper	6,000	150	2.5
Gold	2,000	100	6.2
Indium	4,000	<1	2.5
Iron	3,000	175	10.2
Lead	5,000	20	3.8
Nickel	5,000	500	5.1
Platinum	3,000	200	17.5
Rhodium	3,000	500	70
Silver	1,250	60	5.1
Tin	5,000	1	2.5
Zinc	3,000	70	3.8

** Assuming the pad electrode employed were stationary. Since, in practice, it is moved over the surface being plated, this time should be increased by the area of the surface divided by the area of the pad.*

A practical demonstration at our laboratories will be given without obligation

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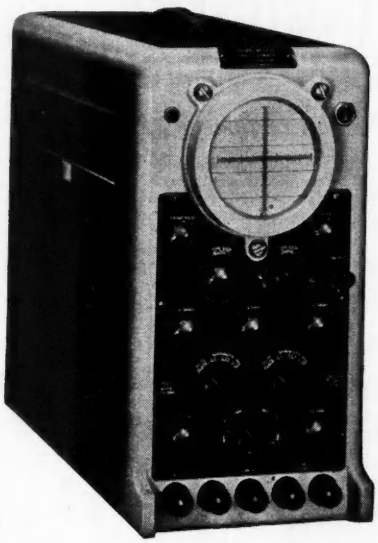

The new Cossor Double Beam Oscillograph

MODEL 1052

Two similar amplifier channels with an approximate gain of 2000 and an upper frequency response of 3 megacycles are features of this new Cossor Double Beam general purpose oscillograph. The repetitive or triggered time base has a sweep duration from 200 milliseconds to 5 microseconds.

The instrument will operate from power supplies of any of the various frequencies and voltages encountered in the Armed Services or from standard civil supply mains. The top and side panels are quickly detachable to allow inspection and a removable plate at the rear of the instrument allows access to tube plates, anode and modulator.

and Voltage Calibrator

MODEL 1433

Primarily designed to be used with the new Cossor oscillograph the Cossor Voltage Calibrator model 1433 provides an accurate means of calibration of input voltages to the plates or amplifiers of any oscillograph. Calibrating voltages are read directly from a wide scale meter without any computation being necessary. Measurements can be made to an accuracy of ± 5% and the instrument can be used in any application where a source of accurately-known voltage is required.

COSSOR ELECTRONIC INSTRUMENTS

ALWAYS USE COSSOR TUBES & VALVES

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Write for illustrated leaflets about both of these instruments

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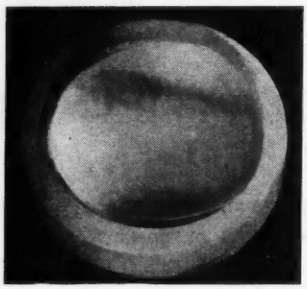
Telephone : CANonbury 1234 (33 lines). *Telegrams : Cossor, Norphone, London.* *Cables : Cossor, London.*

3 WAYS OF APPLYING ULTRASONICS TO INDUSTRY

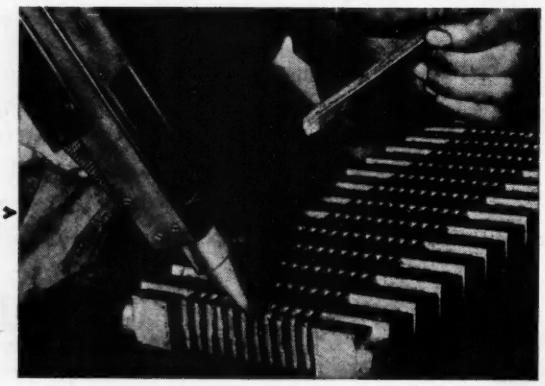


Ultrasonics completely removed mounting compound from this optical glass in 15 seconds.

Cleaning Small Engineered Parts

Ultrasonic energy, used in conjunction with standard solvents, rapidly and effectively cleans small engineered parts that require delicate treatment or are otherwise difficult to clean — for example ball bearings, watches, optical lenses, camera parts, and diamond dies.

In a matter of seconds this process completely removes all foreign particles from the most inaccessible crevices of the engineered part. Despite its effectiveness, it may be used on delicate materials without danger of damage to the surface.



Filling a blowhole in an aluminium casting.

Soldering Aluminium

Ultrasonic soldering equipment provides an efficient and convenient means of soldering aluminium and its alloys. Ultrasonic power is applied to the surface of the metal through molten solder. The cavitation effects produced in the solder completely remove the oxide film on the metal and tinning takes place. The oxide dross appears on the surface of the solder and is easily removed by wiping. No flux is required.

The many applications of ultrasonic soldering include fabricating or altering aluminium patterns; rectifying blowhole defects in aluminium castings; and the bonding of aluminium cables.

A 3/16 inch thick tungsten carbide die, with overall slot length 1 inch, cut in 36 minutes by ultrasonics.

Drilling Brittle Materials

The Mullard ultrasonic drilling equipment is designed for cutting and drilling brittle materials such as glass, precious and semi-precious stones, ceramics, and tungsten carbide.

This method of drilling is both rapid and accurate. Furthermore, as the drill has a reciprocating action, holes can be cut to any shape merely by producing a tool of the required form.

Mullard

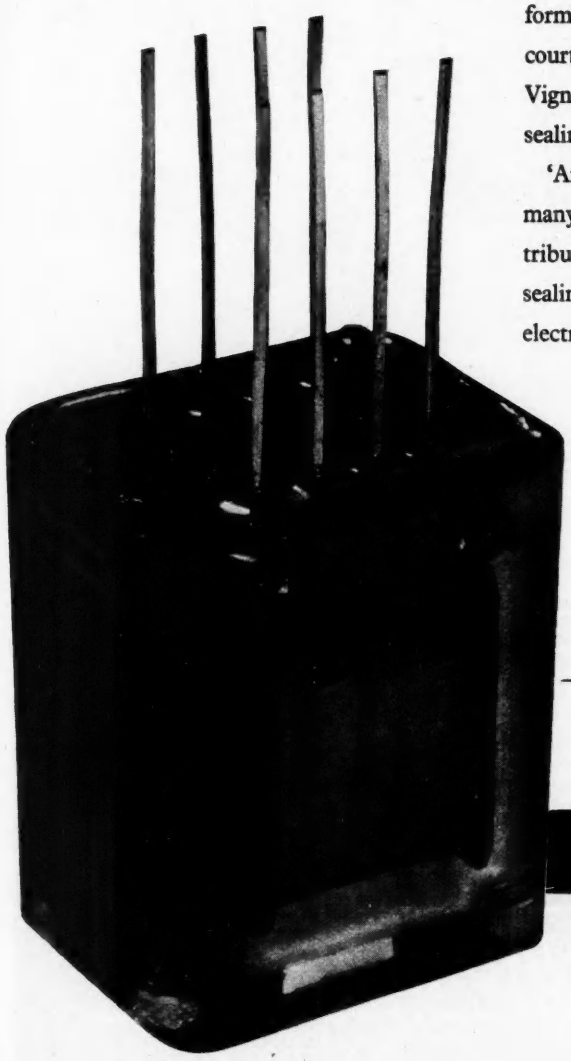
SPECIALISED ELECTRONIC EQUIPMENT

Further information on these industrial applications of ultrasonics may be obtained from the address below.

MULLARD LIMITED · EQUIPMENT DIVISION · CENTURY HOUSE · SHAFTESBURY AVENUE · LONDON · W.C.2

Sealed *with 'Araldite'*

Outstanding adhesion to metals and excellent electrical and mechanical properties combine to make 'Araldite' "the resin of choice" for sealing electrical components. Exceptionally low shrinkage on setting plus resistance to high temperatures, humidity and corrosive agents contribute further to the success of this new epoxy resin for potting or casting applications. 'Araldite' complies with the requirements stipulated for the sealing of Service equipment. Our illustration of a transformer potted in 'Araldite' is published by courtesy of the makers, Messrs. Evershed & Vignoles Ltd., who also use the same resin for sealing resistances and valve assemblies.



'Araldite' epoxies are simplifying production in many industries. Nowhere, however, is their contribution more important than in the potting and sealing of components for radio, electronics and electrical engineering generally.

THESE ARE THE NEW EPOXIES!

'Araldite' (regd.) epoxy resins are obtainable in the following forms:—

Hot and Cold setting adhesives for metals, and most other materials in common use.

Casting Resins for the electrical, mechanical and chemical engineering industries.

Surface Coating Resins for the paint industry and for the protection of metal surfaces.

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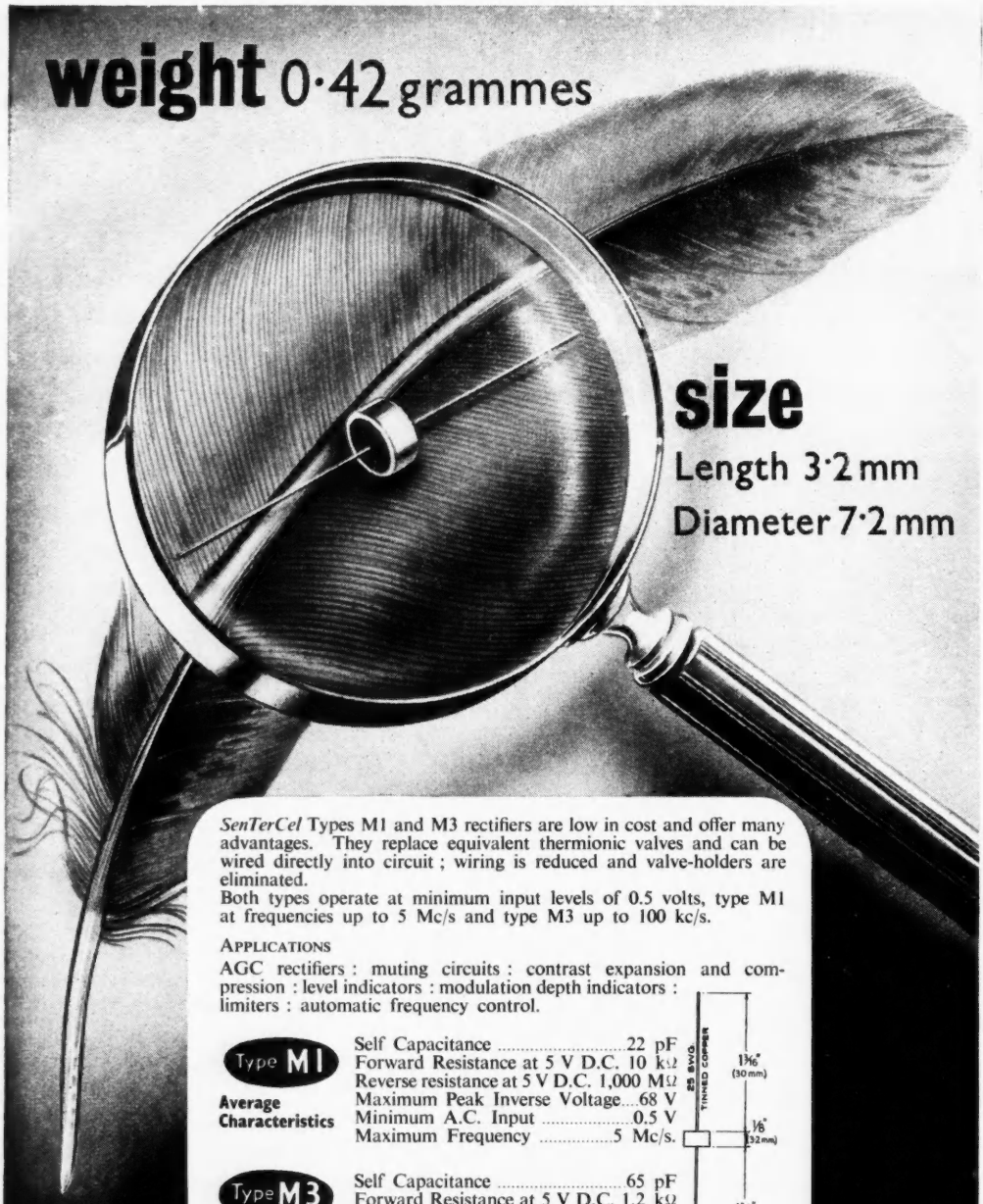
weight 0·42 grammes



size

Length 3·2 mm

Diameter 7·2 mm

SenTerCel Types M1 and M3 rectifiers are low in cost and offer many advantages. They replace equivalent thermionic valves and can be wired directly into circuit ; wiring is reduced and valve-holders are eliminated.

Both types operate at minimum input levels of 0.5 volts, type M1 at frequencies up to 5 Mc/s and type M3 up to 100 kc/s.

APPLICATIONS

AGC rectifiers : muting circuits : contrast expansion and compression : level indicators : modulation depth indicators : limiters : automatic frequency control.

Type M1

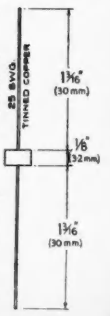
Average Characteristics

Self Capacitance	22 pF
Forward Resistance at 5 V D.C.	10 kΩ
Reverse resistance at 5 V D.C.	1,000 MΩ
Maximum Peak Inverse Voltage	68 V
Minimum A.C. Input	0.5 V
Maximum Frequency	5 Mc/s.

Type M3

Average Characteristics

Self Capacitance	65 pF
Forward Resistance at 5 V D.C.	1.2 kΩ
Reverse Resistance at 5 V D.C.	45 MΩ
Maximum Peak Inverse Voltage	68 V
Minimum A.C. Input	0.5 V
Maximum Frequency	100 kc/s



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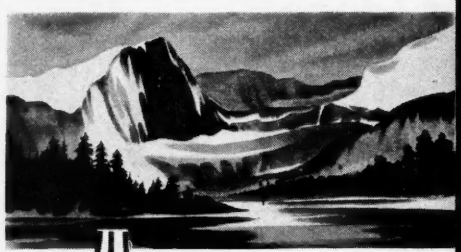
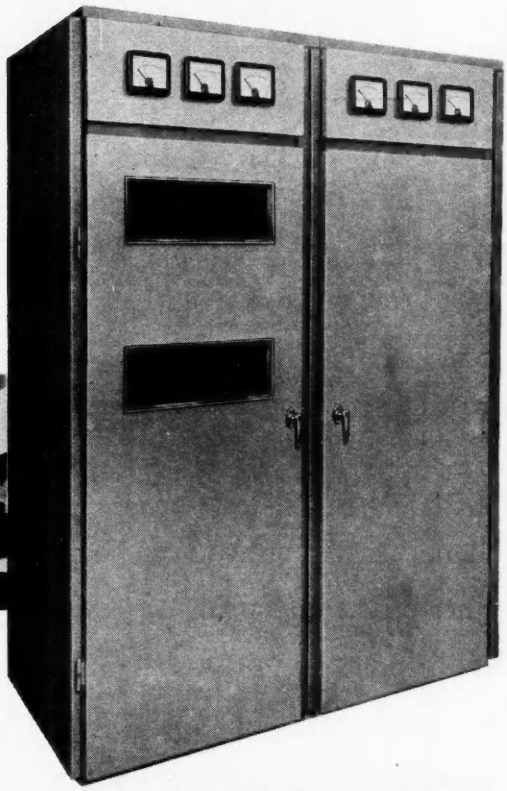
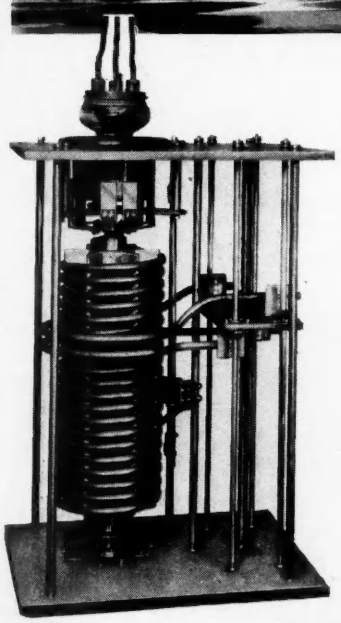
MARCONI HS SERIES

High Frequency Transmitters







The HS.31, 41 and 51 Series of Transmitters have ratings of 2.5 Kw, 10 Kw and 30 Kw respectively ; all provide the following features : operation on any one of 6 spot frequencies or continuous tuning over the entire range, rapid frequency change between pre-set frequencies, easy and safe access for servicing ; RF feed back to reduce distortion ; air cooling throughout with dust filtering ; high overall efficiency.

Service flexibility is the keynote of these transmitters, all of which are designed as linear amplifiers ; ISB telephony, CW and frequency shift telegraphy, double sideband telephony, frequency shift diplex, can all be accommodated.

An outstanding feature of the HS series of transmitters is the compact mechanism employed for anode tuning. The inductance is mounted integral with the valve anode assembly and is continuously variable.

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If the weather is your concern, or indeed if the transmission of any graphic material—drawings, newspapers, legal documents — is a problem, maybe we can help you; write now.

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Helix speed	1 or 2 r.p.s.
Scanning rate	96 lines/inch
Input level (black)	+5 to —40 dbm
Signal frequency	1800c/s AM carrier
Power supply	95 — 125V, 60c/s or 200 — 250V, 50c/s; 200VA

D-649 18″ MUFAX CHART RECORDER

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The Metrovick Stabilised D.C. Power Unit

IN laboratories and meter testing stations there is often a demand for a highly stable d.c. voltage supply. The Power Unit, Type **222**, has been produced to satisfy this demand.

SPECIFICATION

Supply: 200/250V, A.C., 50 c/s., single-phase.

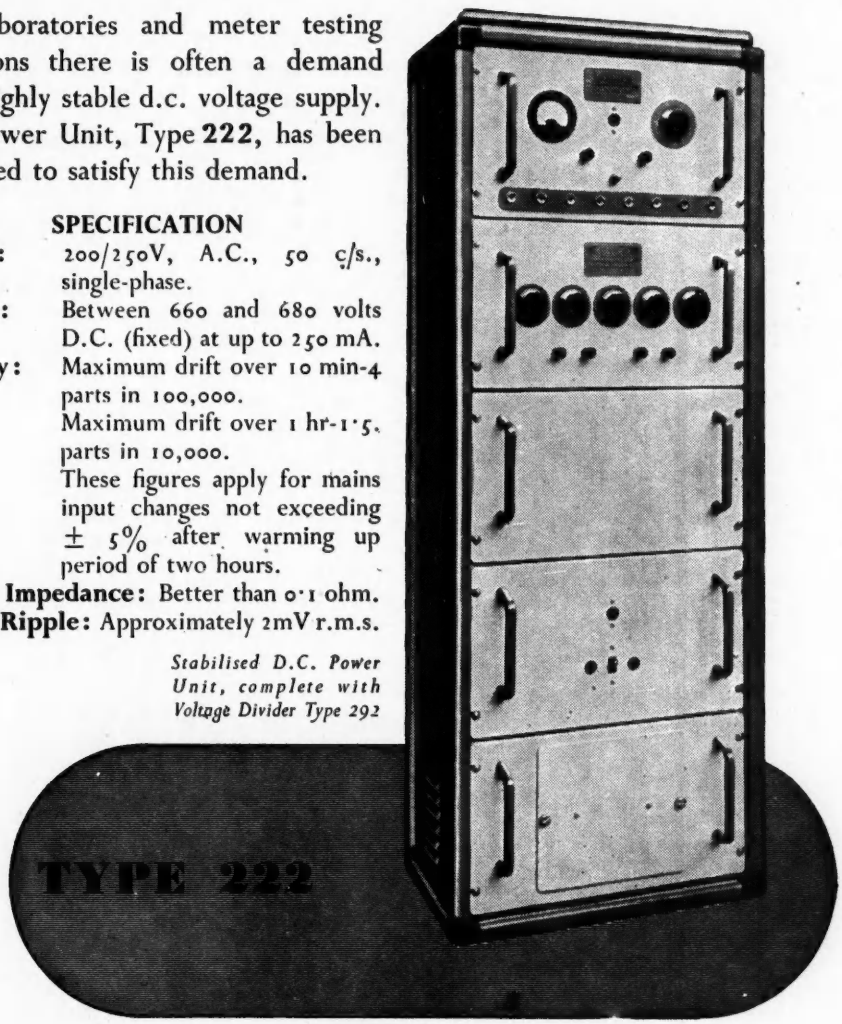
Output: Between 660 and 680 volts D.C. (fixed) at up to 250 mA.

Stability: Maximum drift over 10 min-4 parts in 100,000.
Maximum drift over 1 hr-1·5 parts in 10,000.
These figures apply for mains input changes not exceeding ± 5% after warming up period of two hours.

Output Impedance: Better than 0·1 ohm.

Output Ripple: Approximately 2mV r.m.s.

Stabilised D.C. Power Unit, complete with Voltage Divider Type 292



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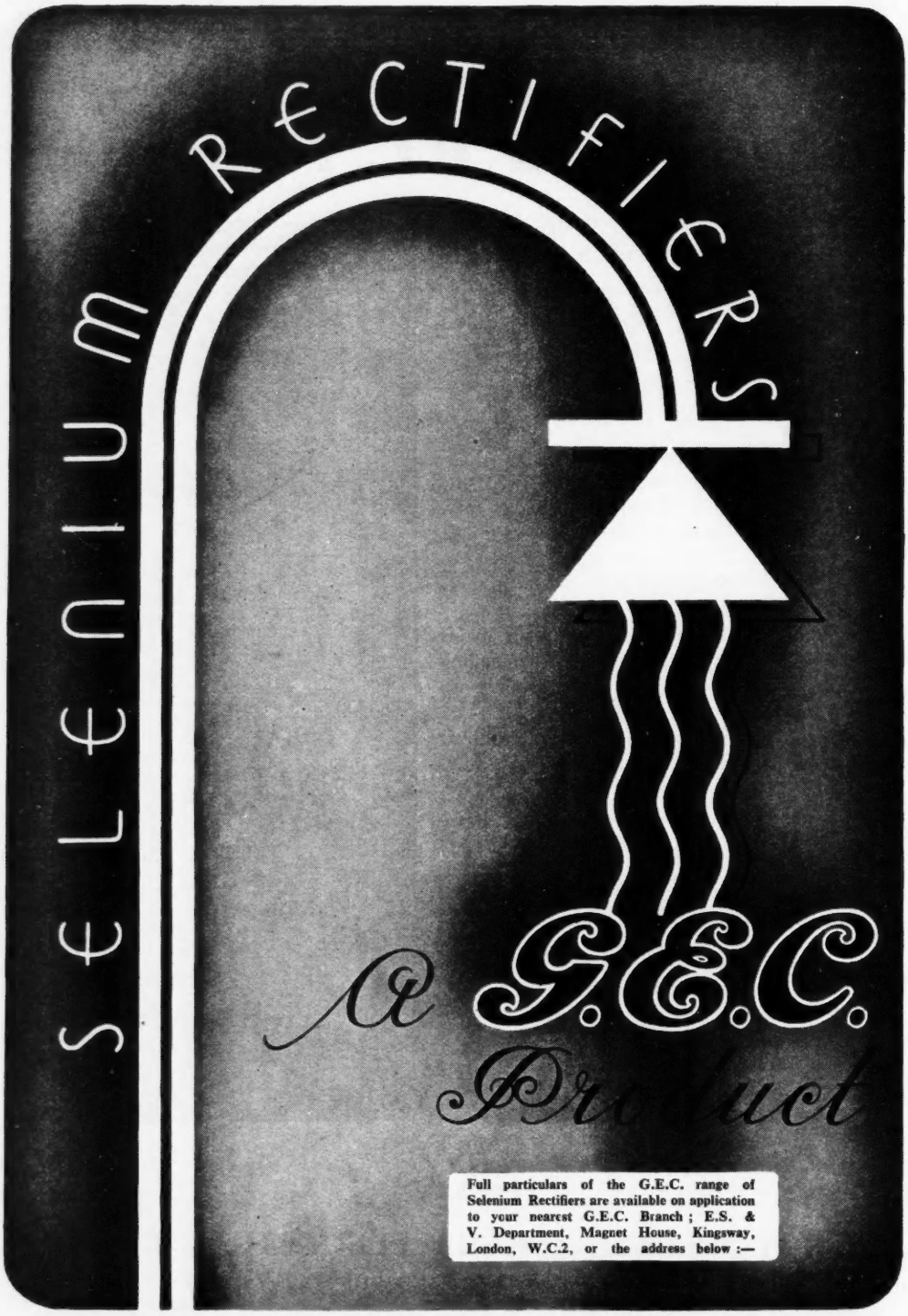
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Full particulars of the G.E.C. range of Selenium Rectifiers are available on application to your nearest G.E.C. Branch ; E.S. & V. Department, Magnet House, Kingsway, London, W.C.2, or the address below :—
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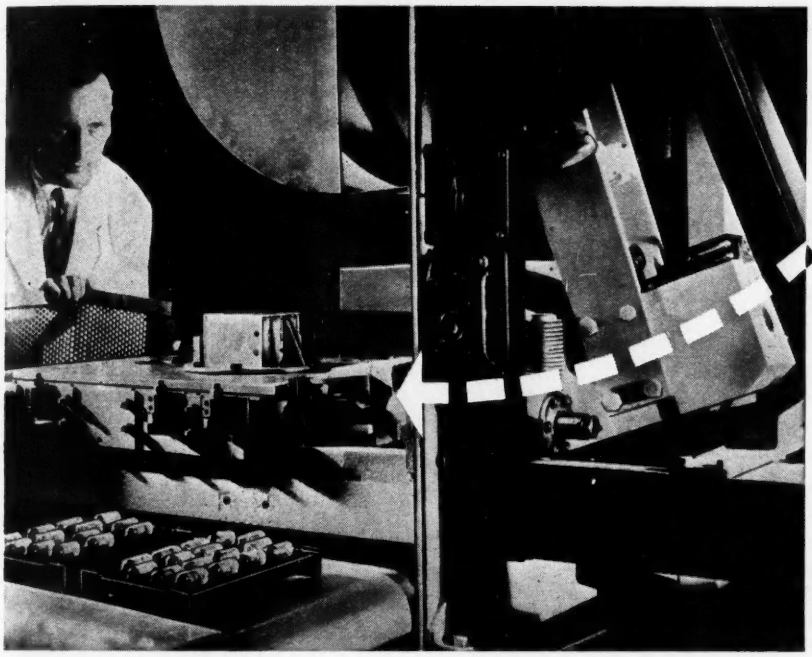
SHOCK TEST.



Exhaustive tests on samples selected at random from every production batch of Mullard *Special Quality* Valves ensure that the exceptional care and skill exercised throughout manufacture have achieved their object.

Shocks of 500 g are given to the selected samples, which are afterwards retested electrically to ensure that their characteristics have remained within the normal limits. The valves are embedded in wax in a steel box which is clamped to the testing table, and a predetermined shock is transmitted to the valves by the hammer head of the pendulum striking the table. By changing the mounting of the box, shocks may be given in both directions along different axes.

The first five of a comprehensive range of *Special Quality* Valves are now available from Mullard. Your enquiries on their employment and the availability of types at present under advanced development are invited at the address below.

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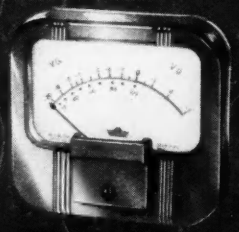
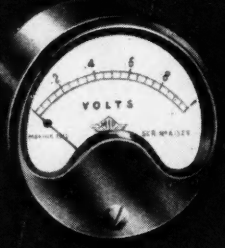
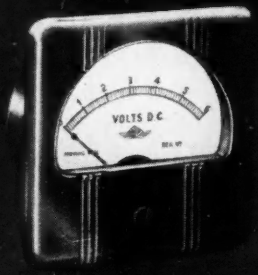
. . . . . will be found within the pages of the Pullin Electrical Measuring Instrument Catalogue. A copy by your side will enable you to plan the instrumentation of your electrical installations at the drawing board stage, and save much time and money later on. Write for a copy stating the particular range of instruments in which you are interested.



SERIES 35, 3½" DIAL V.U. METER for power level indication.



SERIES 20, 2" DIAL MINIATURE RANGE. Round projecting type also available in round or square flush pattern.



SERIES 25, 2½" DIAL MINIATURE RANGE. Square flush type also available in round projecting or round flush pattern.

ROUND PROJECTING TYPE SWITCHBOARD INSTRUMENT (4" AND 6" DIAL SIZES). In pressed steel case. Convertible to flush mounting by separate attachment.

RECTANGULAR FLUSH PATTERN INSTRUMENT. With circular pressed steel base and moulded front cover. Heavy duty cast iron front cover also available.

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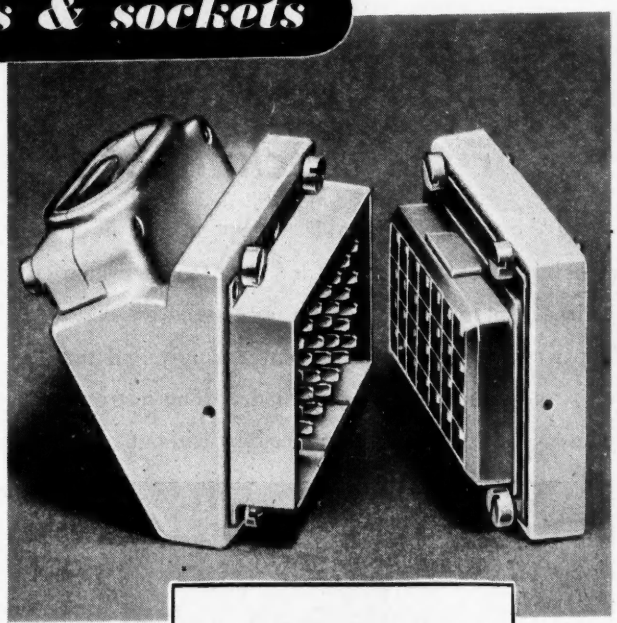

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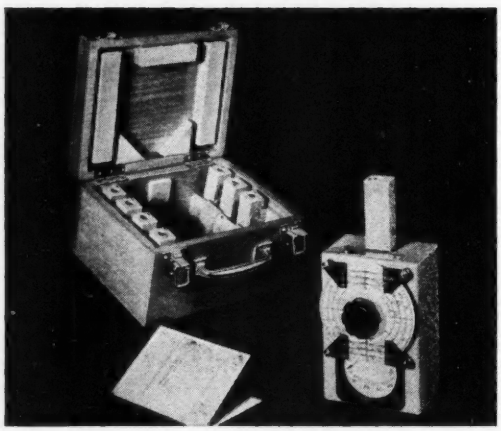
Marconi Wavemeter TF975

For the checking of transmitters

THIS supremely portable absorption-type instrument is directly calibrated in eight bands between 100 kc/s and 100 Mc/s. A primary use is harmonic identification in the case of transmitters having a crystal drive followed by harmonic multiplication. The wavemeter requires no power supply and may be easily held in one hand whilst adjustments are being made. The instrument itself, which measures only 5 in. x 3¼ in. x 3¼ in. over projections without tuning inductor, comprises a tuned circuit in which resonance is indicated by a sensitive moving-coil micro-ammeter with crystal rectifier. It has an accuracy of ±3%. For carrying purposes, a polished hardwood case accommodates the instrument and its eight plug-in coils.



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B.F.

B 19

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Reg'd Trade Mark

SERIES 50 'VARIAC' TRANSFORMERS

With a 'VARIAC' voltages are instantly and minutely adjustable from 0-Line Voltage, or in some cases up to 17% above line voltage. Type 50-B 'VARIAC,' as Illustrated left, is often operated in a 3-gang assembly on 3-phase work to control 21kVA.

Type 200 C.U.H. 'VARIAC'

Type 100-R 'VARIAC'

SPECIFICATIONS

Type	Load Rating	Input Voltage	Current		Output Voltage	No-Load Loss	Net Price £ s. d.*
			Rated	Maximum			
50-A	5 kva.	115 v.	40 a.	45 a.	0-135 v.	65 watts	44 18 6
50-B	7 kva.	230/115 v.	20 a.	31 a.	0-270 v.	90 watts	44 18 6

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REQUEST ALSO OUR 20-PAGE SUPPLEMENTARY CATALOGUE GIVING COMPLETE INFORMATION ON OUR NEW AND COMPLETE RANGE OF AC AUTOMATIC VOLTAGE STABILISERS: THESE RANGE FROM 200 VA TO 25 kVA. PERFORMANCE IS EXCELLENT, FROM NO-LOAD TO FULL LOAD, AND STABILITY IS QUITE UNAFFECTED BY FREQUENCY VARIATIONS.

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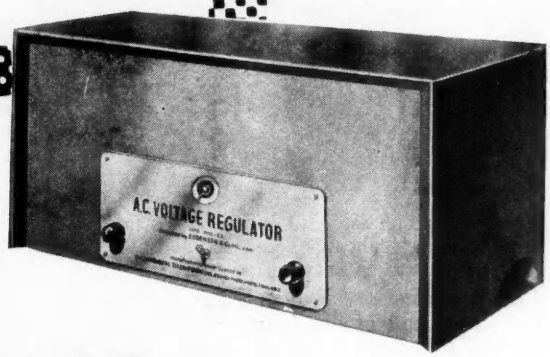

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INPUT FREQUENCY	50 c/s±10%
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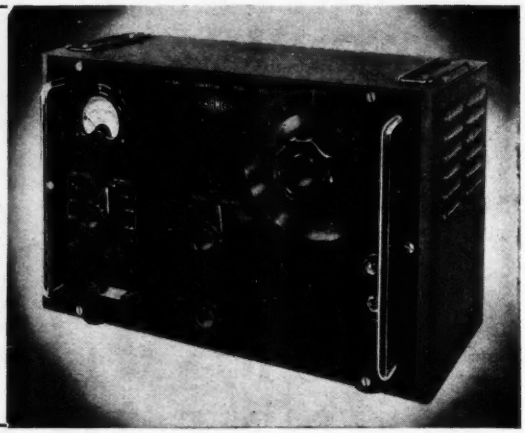

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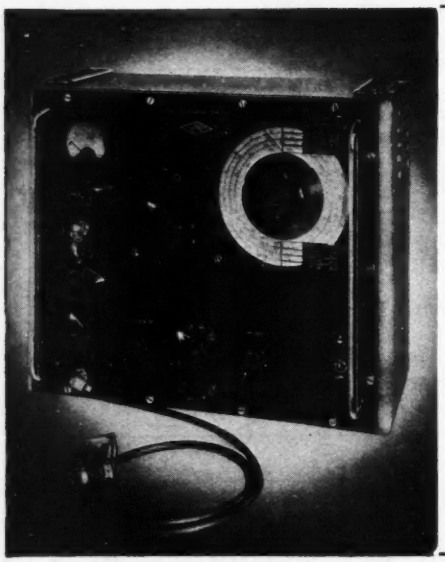

H.F. SIGNAL GENERATOR TYPE 701

- **Frequency Range :** 30 kc/s – 30 Mc/s
- **Output Level :** Constant to within 1 db over entire frequency range.
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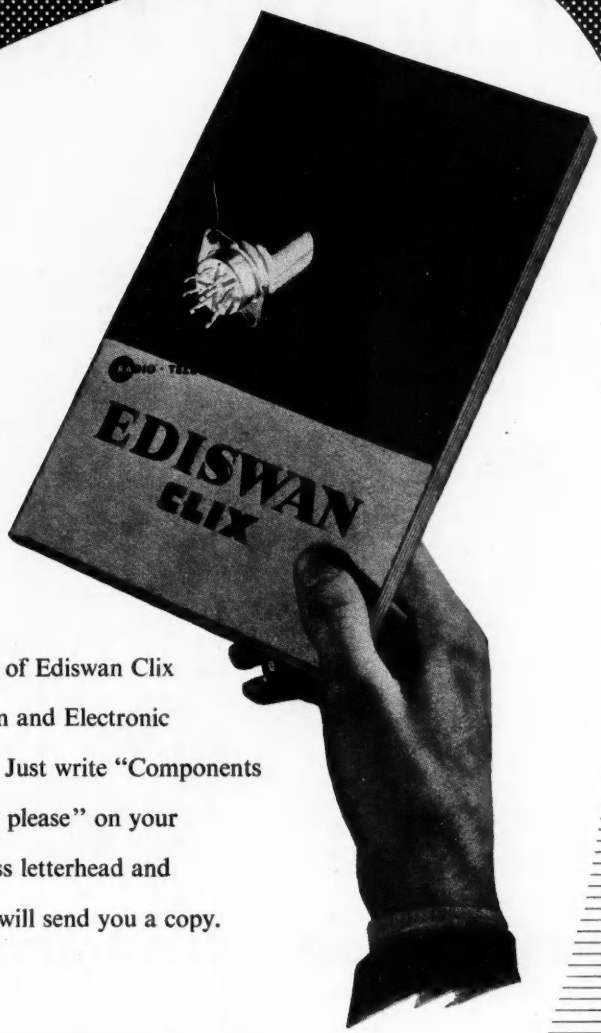

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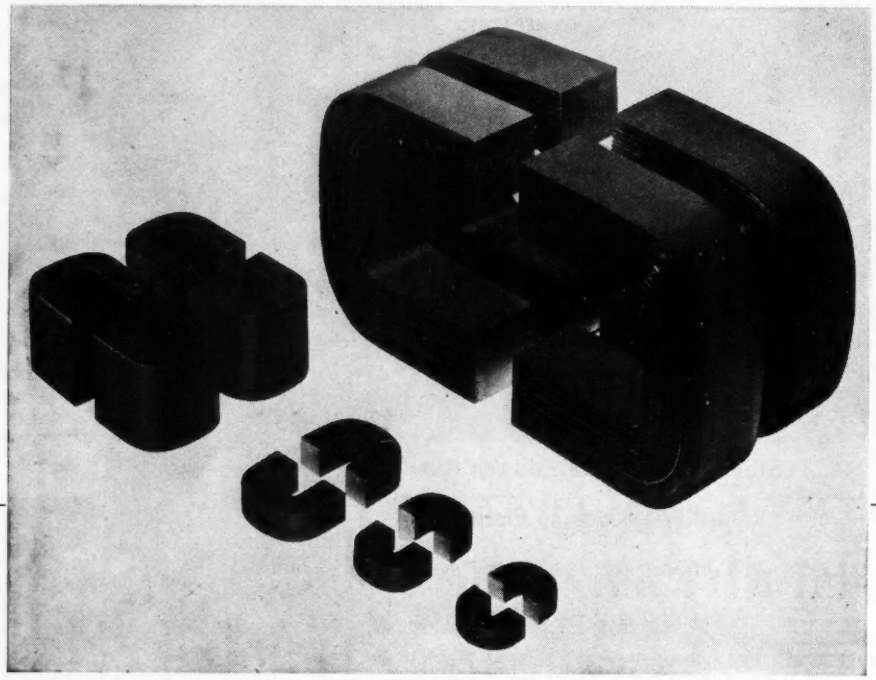

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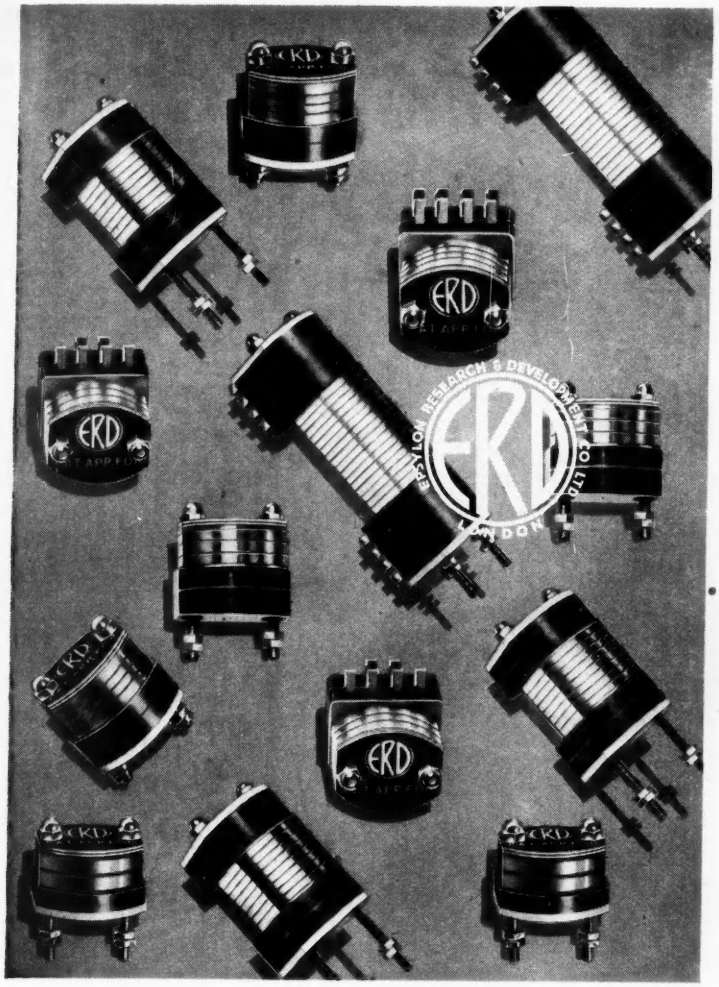

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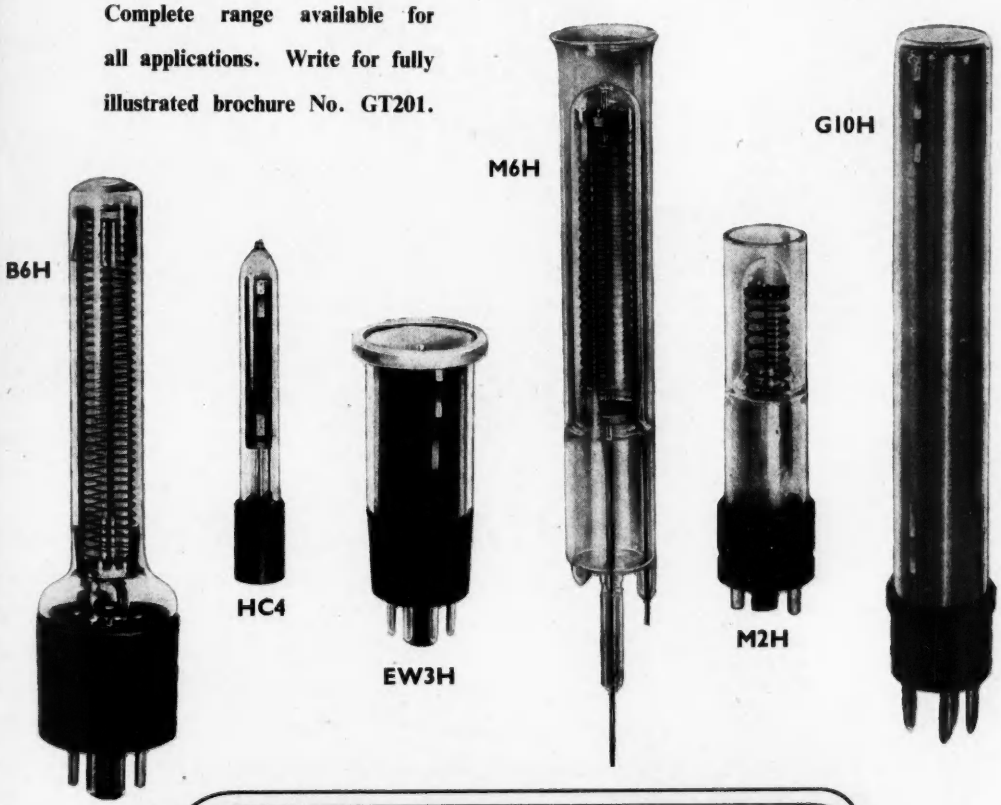

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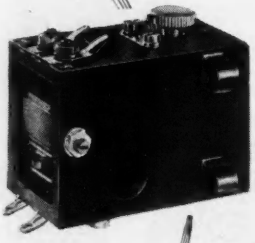

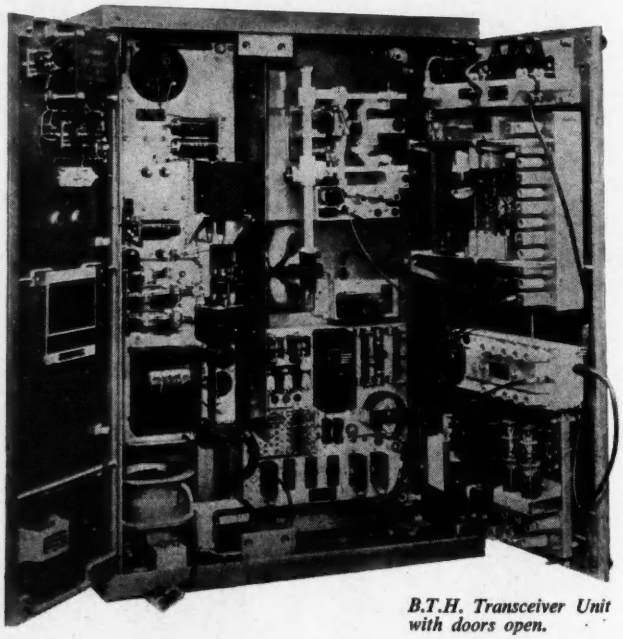

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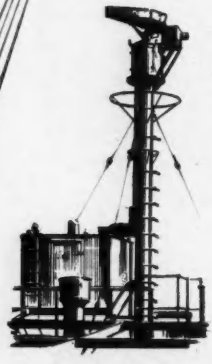

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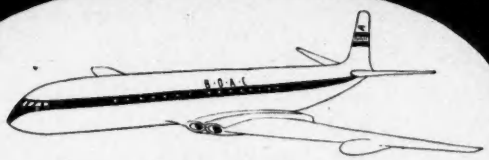

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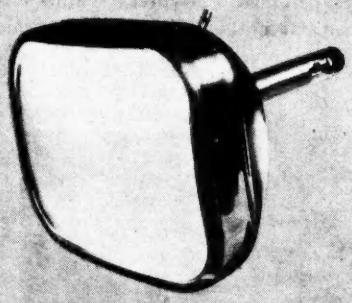

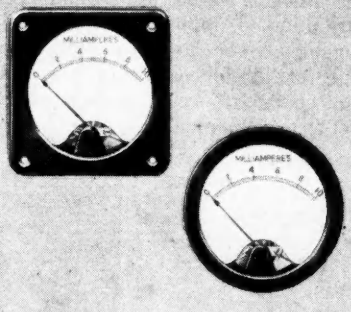

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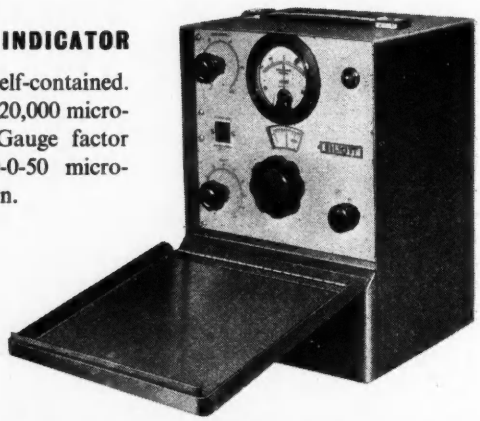

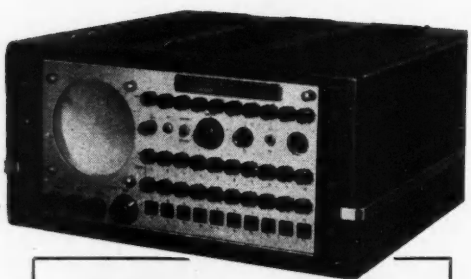

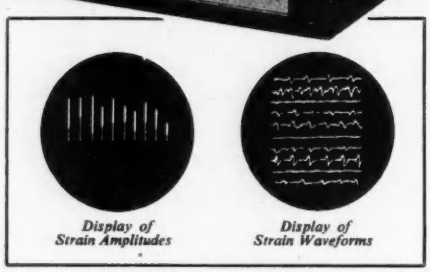

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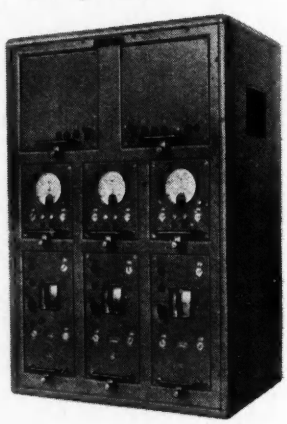

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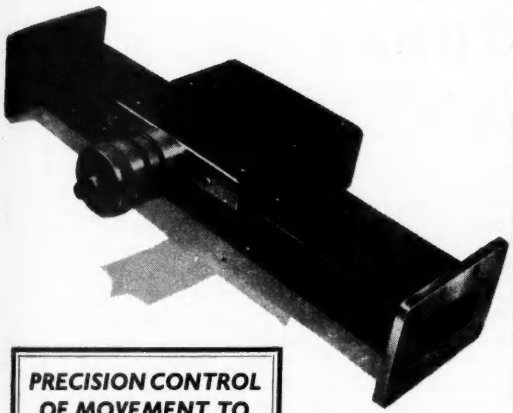

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Managing Editor H. G. Foster M.Sc. M.I.E.E.

Vol. XXVI APRIL 1954 No. 314

Contents

Commentary		135
Epoxy Resins	By R. A. Johnson	136
An A.C. Voltage Stabilizer	By R. G. Ackland	143
A Triode F.M. Discriminator	By I. G. Baxter	146
A High Stability Variable Frequency Oscillator for Centralized Transmitter Drive Units		147
Minimizing Contact Potential in Apparatus Design	By E. C. J. Marsh	148
Pulse Duration Modulator Circuit	By F. Butler	153
A Simple Analogue Divider	By J. L. Douce	155
An Industrial Batching Counter	By R. W. Brierley	157
A Cold Cathode Batching Counter	By P. E. Tooke	160
LEO Lyons Electronic Office		162
Slotted Line Impedance Measurements	By E. G. Hamer	163
The Noise Performance of Television Receivers	By T. S. McLeod	165
New V.H.F. Broadcasting Transmitter for B.B.C.		167
A Time Base Oscillator	By C. H. Barthorpe	168
Short News Items		169
Publications Received		169
R.E.C.M.F. Preview		170
Book Reviews		174
Letters to the Editor		177
Meetings this Month		178

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Classified Advertisements, Page 1
Index to ADVERTISERS, 112

The NEW Z800U and Z801U

High Stability Cold Cathode Trigger Tubes

To help meet the urgent demands for portable nuclear counting equipments, particularly for Civil Defence purposes, **Mullard** have developed two new tubes, the **Z800U** and **Z801U**. These are gas-filled cold cathode trigger tubes, with auxiliary priming discharge, capable of giving long and accurate service. The Z800U has a very stable trigger breakdown voltage, which over the whole life of any one tube will not vary by more than 2%. The Z801U, with a very high charge sensitivity, has been designed for use in conjunction with Geiger Muller tubes.

A new voltage stabiliser circuit employing one of these tubes and providing stability ratios of the order of 200 : 1 at load currents of 40μA is described below. In similar applications which are based on precise voltage discrimination the requirements of designers will be met by these two new Mullard tubes.

THE NEW TUBES AS VOLTAGE STABILISERS

In the circuit diagram V_{in} is the variable input voltage and V_{out} the stabilised output. Two relaxation oscillator circuits are formed: by R_4, C_2 in the anode and C_3, R_2/R_2 in the trigger.

The standing trigger voltage is directly proportional to V_{out}. Values of R_2, R_3 are such that the tube fires when V_{out} reaches a predetermined value, say V_1. C_2 then discharges, the tube extinguishes, and C_2 commences to recharge at the expense of C_1. V_{out} falls to some value, V_2, when the recharging of C_1 through R_1 overrides the drain to C_2. V_{out} then rises again to V_1 and the cycle is repeated.

If the load current is increased or V_{in} is lowered, V_{out} will take a longer time to rise to V_1 and the frequency of operation will fall. C_1 will discharge less frequently and the mean output will remain unchanged. The ripple in the output voltage is approximately 2% of V_{out}, and the overall performance that can be expected from such a stabiliser is indicated in the accompanying table.

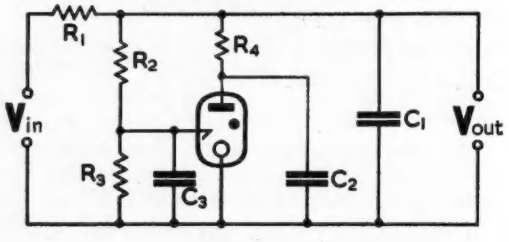
A comprehensive report outlining the various considerations in the design of very low current stabilisers is available on request.

PRINCIPAL CHARACTERISTICS

Tube Type No.		Z800U (CVX2236)	Z801U (CVX2255)
Max. mean cathode current (averaging time 15 secs)	(mA)	2.5	2.5
Max. peak cathode current	(mA)	10	10
Anode voltage working range	(V)	220 to 275*	150 to 170
Nominal maintaining voltage at 2mA	(V)	110	105
Triggering characteristics:— Nominal trigger breakdown voltage at Va=260V	(V)	146	—
Min. energy required by auxiliary cathode to initiate main discharge	(μμC)	—	45
Base		B9A	B9A

* Trigger voltage not less than + 50V.
The maximum operating speed of both tubes is largely determined by the circuit and is of the order of 400 c/s.

STABILISER CIRCUIT †



CIRCUIT PERFORMANCE

Tube employed		Z800U (CVX2236)	Z801U (CVX2255)
Output Voltage Range	(V)	220 to 275	150 to 165
Mean Load Current	(μA)	30	60
Load Current Range	(μA)	±10	±35
Input Voltage Range for Stable Output	(V)	900 to 1200	350 to 480

These values are, of course, inter-related. Mean figures are given.

†N.R.D.C. Brit. Pat. Appl. 20214/51

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ELECTRONIC ENGINEERING

VOL. XXVI No. 314

APRIL 1954

Commentary

CONSIDERABLE satisfaction will be felt with the recent statement by the Postmaster-General in the House of Commons outlining the financial basis on which the BBC will operate for the next three years.

Expenditure has been in excess of revenue for some time past and in order to make both ends meet the BBC has had to draw heavily on its reserves. With a large development programme under way both in sound and television it has become all too obvious that the BBC must increase the main source of its income, namely the licence fee.

Briefly, the combined licence fee for sound and television will go up to £3 as from 1 June. Of the total revenue the Exchequer will retain £2M annually for the next three years and in the second and third years it will keep a further £750 000 which will be handed over to the proposed Independent Television authority. An annual sum of £1·6M will be given to the Post Office to cover the cost of collecting the licence fees and removing the causes of interference. The balance will go to the BBC.

The number of sound receivers, for which the licence fee is to remain at £1, has tended to remain steady, but it is predicted that with the present rate of growth of television in this country the BBC will receive some £17M in the first year, £18½M in the year after and £20M the third year, by which time it is anticipated there will be 5 300 000 television receivers—roughly one receiver for every ten of the population.

This is a large income but it is no more than the BBC estimated it would require and at long last it will allow the BBC to proceed with its development plans without incurring financial crises.

It is now expected that the plan for national coverage of the present television service will be complete by the end of next year and when this is done it will give coverage to 97 per cent of the population of the United Kingdom.

At the same time, there will be a considerable extension of the facilities for the service both in London and the Regions.

Colour television remains, as before, a technical problem, rather than one of finance as the questions of compatability and frequency allocations have not yet been answered and no one as yet can predict when colour television will be available. All that can be said at this stage is that it will not arrive within the present financial period of three years.

The second television service to be given by the BBC is now much nearer and both they and the television industry are preparing for its inauguration. New television receivers designed to receive the dual transmissions of the BBC together with those of the independent television authorities, will be on display at the Radio Industries Exhibition at Earls Court in the autumn, although it is by no means clear when the new transmissions will start.

The television set maker is, in fact, faced with somewhat of a dilemma at the moment, for the public has come to believe that both the second service and the independent television programmes are just round the corner.

It is perhaps difficult for the layman to appreciate how much work is involved to bring these plans into being. As far as we know, the BBC have carried out no studies in the way of propagation or in the problems of site locating and testing. It is only this month that the BBC have taken delivery of the first of six experimental television type transmitters for the particular purpose and results cannot be expected immediately.

These studies are very time-consuming and it is reasonable to suppose that at least another twelve to eighteen months must elapse before the second service is in actual operation.

The position with regard to the independent organizations is not known, but it is unlikely that these bodies are any more advanced.

A most gratifying feature of the increased resources of the BBC is that a start can now be made on the VHF FM network. A number of transmitters have already been ordered and within the next twelve months or so the new transmissions should be heard. The emphasis remains on television, but sound broadcasting has by no means outlived its purpose and the exceptionally high quality of reproduction with freedom from interference obtainable with the new system will attract a growing and more critical audience.

Epoxy Resins

By R. A. Johnson*

During the last few years electrical engineers have become familiar with the "Araldite" range of Epoxy Resins, either as adhesives or casting resins. This article presents a complete picture of the methods of use and properties of the casting resins. It also gives some indication of new developments which are taking place with these materials.

THE epoxide resins which are available under the name of "ARALDITE" (registered) have, by reasons of their many oustanding properties, become well known during the comparatively few years in which they have been available. This is particularly true in the electrical engineering industries where these materials, in the form of adhesives and casting resins, have made possible the development of electrical equipment along lines not previously possible. Since their introduction, however, the resins which were originally available have themselves been developed to a considerable degree. Furthermore, in the years since their introduction, much has been learned of their behaviour, their properties and techniques of use. Originally there was only one type of casting resin, this being known as casting resin B, and this is still the type most widely used.

Casting Resin B

This is supplied in the form of lumps, golden yellow in colour, which is used with hardener 901, a white powder, both of which can be stored under normal conditions for periods up to two years. In use, the resin is heated to 120°-140°C, at which temperature it can be kept for several days without any deleterious effect. While at this temperature, 25-30 parts by weight of hardener 901 per 100 parts of resin are added to the resin and stirred in until it has melted. As soon as the hardener is added and providing that the temperature remains above 100°C, the process of curing begins and at 120°C the pot life of the resin-hardener mix is between 1 and 1½ hours. Curing can be carried out at any temperature between 100°C and 200°C, the times and temperatures being as follows:—

Temperature	(°F.)	392	346	310	274	238	212
	(°C.)	200	180	160	140	120	100
Curing Times	(hours)	1–2	2–3	5–7	7–10	10–14	14–20

The most suitable temperature for curing casting resin B is dependent upon the materials of the component which is being treated. In some instances, the maximum curing temperature will be dictated by one or more of the materials which are being encased, as several materials and pieces of equipment used in the electrical industries are not able to withstand very high temperatures. Apart from such considerations it is usually an advantage to cure at the lowest economic curing temperature. This particularly applies to very large castings where it is advisable to keep the temperature down in order to minimize the shrinkage due to the thermal linear coefficient of contraction. As will be seen from the properties listed in Table 2, the coefficient of expansion and contraction of casting resin B is about 60 parts per million but this may be reduced to about 25 parts per million by use of suitable inert fillers.

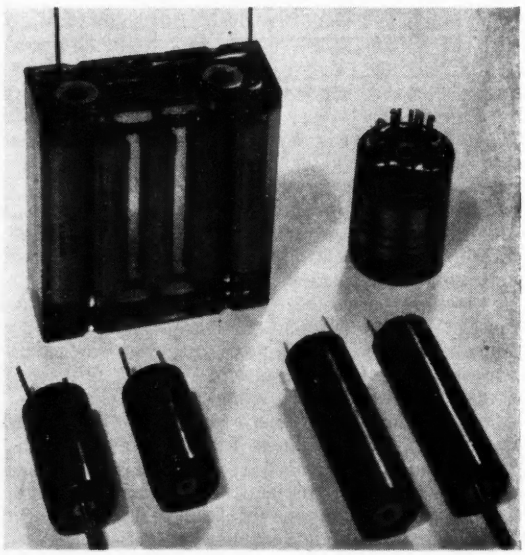
Fillers

There are a large number of materials which may be used as fillers but they are not all equally suitable, as the percentage which the resin plus hardener will tolerate varies from 25 per cent to as high as 350 per cent. Among materials which have been tested are slate powder, mica dust, glass powder, quartz meal, sand and ground porcelain. Of these, it is found that sand of a type similar to that used in foundries can be used in the largest quantity but it is not necessarily the most suitable filler, as there is a tendency towards settling out during the curing process. The filler which offers the best all-round properties seems to be quartz meal of a particle size smaller than that which passes a 120 B.S.S. mesh sieve. Suitable silica sands, known as CH120 and M120 are marketed by Mellor Mineral Mills Ltd., of Etruria Vale, Stoke-on-Trent. Approximately 58 per cent of CH120 will pass a 300 mesh sieve while all will pass a 120 mesh, whereas 71 per cent of M120 will pass a 300 mesh sieve, all passing through 120 mesh. Of this type of filler, quantities between 150 and 200 per cent may be tolerated, and will remain in suspension in the resin during the curing operation. Apart from reducing the thermal linear coefficient of expansion, the addition of fillers also provides the means of increasing the heat conducting properties (see Table 2) and considerably reducing the cost of the resin mix, as these fillers usually cost only a few pence per pound.

Mixing of Fillers

When fillers are being used they have the effect of raising the viscosity of the mixture, and with most fillers it is the

Fig. 1. Resistors potted in Araldite D
(By courtesy of Evershed & Vignoles Ltd.)



* *Aero Research Limited.*

viscosity at pouring temperature which limits the amount of filler which may be added. The increase in viscosity means that there is a much greater possibility of any air which is entrapped in the mould being unable to escape, thus causing blow-holes in the final casting. In order to obviate this possibility, it is advisable to subject the resin and filler to heat (120°-140°C) under vacuum before the hardener is added. The most satisfactory way is to treat these before mixing in order to pull off any moisture which may be present in the filler, and also any which may be on the surface of the casting resin. When these are then mixed together (which may be done out of the vacuum chamber) all that is left to pull off is any air which may be included in the mixing operation. For this purpose, about 20 minutes in vacuum of 1-2mm of mercury is recommended. The time may be easily judged, however, from the fact that when the vacuum reaches this level a rather violent movement may be observed in the resin-filler mix which will cause the mixture to rise to a height equal to about twice its normal depth in the container. When this has died down and the surface has become more or less still, the mixture may be removed from the vacuum chamber. If the mixture is not required for immediate use, it may be run off into trays and allowed to solidify, being subsequently broken up and stored. If required immediately, however, the correct quantity of hardener 901 should be added and after stirring until the hardener has dissolved, the whole may be again subjected to a vacuum treatment. For this operation, a vacuum of 10mm is sufficient and this should be held for about ten minutes. Again a small movement occurs in the mixture but not as violent as that which takes place when the resin and filler are first subjected to vacuum.

Casting

The mixture may then be removed from the vacuum chamber and poured into the moulds which have been previously prepared. Unless the shape of the mould is very complicated, further vacuum treatment should not be necessary, but where the conditions demand it, the filled mould should also be placed in the vacuum chamber at a temperature of about 120°C and maintained under vacuum for about five minutes. The mould may then be transferred to an oven to complete the cure, or it may be allowed to cool and the resin cured at a later time. Such would be the technique used if curing were to be carried

TABLE 1

Comparison between Average Physical Properties of Porcelain and Casting Resin B with 200 per cent Filler

	PORCELAIN	CASTING RESIN B + 200% QUARTZ MEAL
Specific gravity	2·6–2·8	1·7–1·8
Tensile strength	4 300– 7 000 lb./sq. in.	10 500–12 000 lb./sq. in.
Compressive strength	57 000–64 000 ,,	28 000–31 000 ,,
Fatigue strength	8 500–11 000 ,,	17 000–20 000 ,,
Modulus of elasticity	$9–10 \times 10^6$	$1·7–2·0 \times 10^6$

TABLE 2

Physical Properties of Casting Resin B, with and without Fillers

	TEST METHOD	RESIN MIX 1	RESIN MIX 2	RESIN MIX 3	RESIN MIX 4	UNIT
Approx. adhesive strength (bonding Avianel M)	—	2 900– 3 750	2 000– 2 700	2 550– 2 900	1 150– 2 500	lb./sq. in.
Ash content	—	0·02–0·03	15–16	60–61	69–70	per cent
Combustibility	—	5–10	8–10	8–10	8–10	seconds
Compressive strength	ASTM D695-49T	15 500-18 500	17 000-18 500	28 000-31 000	206 000-220 000	lb./sq. in.
Decomposition	—	340–360	335–345	340–345	345–350	°C
Fatigue strength	VM77103	12 700–17 000	9 000–11 300	17 000–20 000	7 100– 8 500	lb./sq. in.
Flexural strength	ASTM D790–49T Schopper test bar 120 × 15 × 10mm.	12 800–17 000	9 300–11 400	10 000–14 000	7 000– 8 500	lb./sq. in.
Heat resistance (Marten's test)	Federal L–P–406a–2011	105–115	110–120	120–125	125–130	°C
Modulus of elasticity	ASTM D638-46T	$0·42–0·57 \times 10^6$	$0·64–0·78 \times 10^6$	$1·7–2·0 \times 10^6$	$2·1–2·6 \times 10^6$	lb./sq. in.
Shrinkage (depending on curing temperature)	—	0·5 – 2·5	—	—	—	per cent
Specific gravity	—	1·2 – 1·3	1·25 – 1·35	1·7 – 1·8	1·9 – 2·0	—
Tensile strength	ASTM D651–48	8 500–11 000	9 000–11 000	10 500–12 000	5 000– 5 600	lb./sq. in.
Thermal conductivity	—	approx. 0·17	—	approx. 0·54	approx. 0·73	kcal/m²h°C
		,, 0·008		,, 0·036	,, 0·036	watts/ich²/°C/in.
Thermal coefficient of linear expansion	ASTM D696–44	$60–65 \times 10^{-6}$	60×10^{-6}	$30–35 \times 10^{-6}$	$25–30 \times 10^{-6}$	parts per million per °C
Water absorption, 10 days at 20°C	ASTM D570–42	0·25–0·35	0·25–0·35	0·25–0·3	0·15–0·2	per cent weight
1 hour at 100°C	—	0·3 –0·45	0·3 –0·4	0·3 –0·45	0·2 –0·3	,, ,,
COMPOSITION OF RESIN MIX						
Araldite casting resin B	—	100	100	100	100	parts by weight
Hardener 901	—	25–30	30	30	30	,, ,,
Filler	—	—	25 slate powder	200 quartz or porcelain flour	300 quartz sand	,, ,,

out overnight at a temperature of 100°C which appears to be favoured by most manufacturers. As already mentioned, there are advantages in keeping the curing temperature down to 100°C, but in addition, electric power is sometimes cheaper during the night-time.

Moulds

A wide variety of materials may be used for manufacturing moulds suitable for use with casting resins but, in general, it may be said that the simplest form of mould is usually the best. The design of mould will obviously be dictated by the nature of the component being treated but wherever possible sharp corners or sudden changes of section should be avoided. It has been found that aluminium alloys appear to be the most suitable materials from which to fabricate moulds, although steel is quite satisfactory and brass (sometimes chromium plated) is also used. Araldite casting resins have excellent properties of adhesion to metals and it is necessary to use a parting compound to prevent the cured resin from adhering to the mould; the use of curing temperatures in excess of 100°C rules out the use of most waxes. The parting agents recommended are those belonging to the silicone groups such as Releasil 7 grease and Releasil 14 liquid, both of which are procurable in this country from Midland Silicones Ltd., 19 Upper Brook Street, London, W.1, or

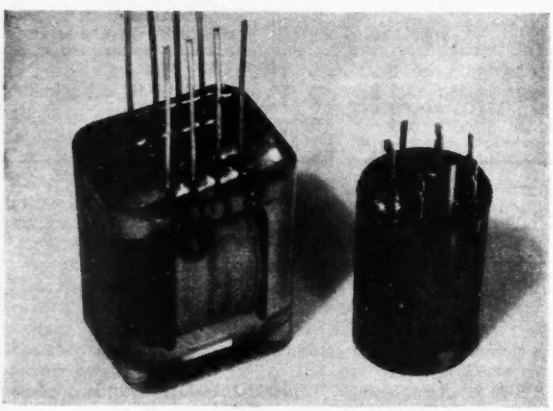


Fig. 2. Transformers potted in Araldite D
(By courtesy of Evershed & Vignoles Ltd.)

Silicone Resin R205 which may be obtained from I.C.I. Ltd., Nobel Division, 25 Rothwell Street, Glasgow, C.2.

When a mould is new it quite often happens that, when silicone greases are used, the first two or three castings produced in it do not free themselves very easily and it is therefore suggested that before casting into a new mould, the process of applying the parting agent and curing is carried out with the mould empty. After this treatment it is usually found that separation of the mould and casting does not present any difficulty. It should be remembered, however, that the fact that the resin has a higher shrinkage rate than the mould material means that if cores are used when casting, they must be removed while the casting is still hot, otherwise their removal will be impossible due to the shrinkage of the resin on to the core.

If the mould is itself large, this should be heated to a temperature slightly higher than that of curing before the resin mix is poured. This prevents the resin mix from cooling, thus making the removal of any air bubbles present more difficult owing to the increase in viscosity of the mix. With sheet metal moulds, however, this is not necessary.

It sometimes happens that the number of castings of any particular shape which are required is very limited, and the cost of metal moulds is not justified. In such instances the use of moulds made from sand offers a convenient and economic method of producing the required casting. To produce sand moulds, a wooden pattern is first made and around this is moulded the sand mixture. This is made by adding three parts by weight of resin 285 (Aero Research Ltd.), to 100 parts by weight of sand and, after mixing together, four parts of water are mixed in. It is sometimes an advantage to add one or two parts of Dextrine. This mixture after moulding round the pattern, is baked for one or two hours at a temperature of 150°C with the wooden pattern removed. In order to seal the pores of the sand mix, one and three parts of water and water glass respectively are brushed over the moulding surfaces, a drying period being allowed between each coat.

Uses of Casting Resin B

The most extensive uses of casting resins are found in the electrical industries where the combined properties of adhesion, moisture resistance, mechanical strength, temperature and ageing resistance, combined with excellent electrical properties are employed to produce equipment which was not practicable until comparatively recent years. The properties of casting resin B are shown in Table 3 and it will be seen that the high strength of adhesion, coupled with good electrical insulation value, means that components may be satisfactorily joined together but at the same time be adequately insulated one from the other. This is particularly useful when it is desired to embed the windings of electric motors in which the encasing of the whole after winding prevents movement of the wires in subsequent use and at the same time insulates the windings. Among the

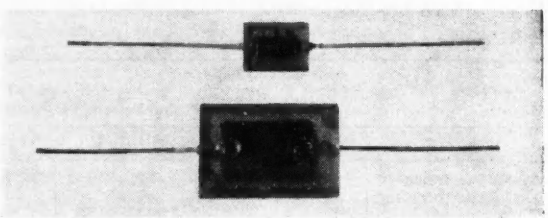


Fig. 3. Silver mica capacitors cast in Araldite casting resin B
(By courtesy of London Electric Manufacturing Co., Ltd.)

types of component which are being manufactured with the aid of casting resins may be listed: transformers, bushings, capacitors, insulators, terminal blocks with cast-in terminals, resistors, bobbins, servo motors, transistors, relays and potentiometers.

One development which appears to be gaining ground rapidly is the production of insulators from casting resin B plus silica, as a substitute for porcelain insulators. Table 1 gives a direct comparison between the properties of each type of insulator and it will be seen that the advantages generally lie with the insulator made from casting resin.

Any metal fittings required, which normally have to be attached to the porcelain, may be cast in situ, and due to the adhesion of the casting resin to the metal, freedom from electrical interference is obtained. Furthermore, the dimensional accuracy possible with casting resin is of the order of 0·1-0·2 per cent as compared with the normal variation of five per cent which is found in ceramics. Possibly the greatest advantage, however, is the resistance of the casting resin insulator to thermal and physical shock. Filled resin castings may be repeatedly dropped on to a concrete or stone floor without causing any damage other than possibly chipping the outside surface, whenever a protrusion or edge hits the floor at an awkward angle. Such castings may also be heated to temperatures of 100°C or more and plunged straight into cold water many times before showing any signs of cracks. The dielectric constant of the cast insulator is usually better than that of the

ceramic insulator and the electrical breakdown strength is practically the same.

The largest users of casting resin B are transformer manufacturers and it has been found that a potted transformer offers many advantages over the conventional oil-immersed transformer. Among these advantages is the facility it affords of designing a transformer of a given capacity which is considerably smaller in bulk and consequently lighter in weight. Insulation resistance is also higher than that of a taped transformer and heat transfer compares very favourably with that of an oil-filled transformer. Possibly the most important factor, however, is that transformers potted in resin will satisfactorily withstand the full tropical tests laid down by Service standards and are not likely to catch fire if overheated. Many other items of electrical equipment are also being encased in resin in order to meet the requirements of tropicalization.

New Casting Resins

As mentioned earlier, since casting resin B was introduced, much development work has taken place and several other types of Araldite resins are now offered which are of particular interest to the electrical engineer. These new products all adhere strongly to metals and may be listed as follows:

1. Casting resin type D
2. Casting resin type F
3. Flexible casting resin type 33/896
4. Expanded casting resin type 33/912
5. Impregnating casting resin type 33/915

Of these, items 3, 4 and 5 are still considered as experimental products.

Casting Resin D

This is a cold setting resin used in conjunction with hardener 951 both of which are solvent free liquids. In use, ten parts by weight of resin D is mixed with one part by weight of hardener 951 (nine parts by volume of resin D with one part by volume of hardener 951) and thoroughly mixed together. The mixing is of great importance, as, unless this is complete, free hardener will remain in the resin with the result that complete hardening will not take place; there is the further danger that free hardener may cause corrosion of copper or brass. When mixed correctly there is no danger of corrosive action and should this occur it is a sign of faulty mixing. It has been found that the most suitable and possibly the easiest way of mixing these materials is by means of an electric-vibrator mixer working at a frequency of 60 cycles per second. By such means it is possible to mix about 2lb of resin and hardener in about two minutes (by other means at least 15 minutes would be required for this amount) and by such methods of mixing air is not added to the mixture. When the hardener has been added an exothermic reaction occurs and for this reason it is recommended that the quantity mixed should be kept to a minimum and that the container used for mixing should be made of a material which will enable the heat generated to be dispersed as quickly as possible. It is helpful if the container is of such dimensions that the depth of resin is small. It is possible to control the exotherm by maintaining the resin and hardener at a low temperature, say 5°C, before mixing. They should also be kept at this temperature immediately after mixing and poured into a cold mould. By regulating the rate of temperature rise of the mould and resin the exotherm may be controlled. After such treatment it is essential to post cure at a temperature of between 80° and 100°C for about two hours in order to fully develop the properties of the resin.

After the hardener is added the mixture remains pourable for 1½ hours at normal room temperatures (or considerably longer at lower temperatures) after which time setting takes place. Full curing, however, takes at least 24-36 hours at room temperatures but after about five hours the resin has set sufficiently to enable the casting to be removed from the mould. Although this is essentially a cold setting resin, the curing process may be accelerated by means of heating, which also has the advantage of improving the physical properties of the cured resin.

The electrical characteristics of type D are similar to those of casting resin B up to about 60°C but its heat resistance is lower and it softens at temperatures above 50°-60°C. It is less water resistant, but samples have satisfactorily withstood tropical tests.

Casting Resin F

Casting resin F, which is a solvent free liquid resin of fairly high viscosity, may, unlike the casting resins already mentioned, be used as a cold setting resin using hardener 951, or as a hot setting resin using hardener 901.

When used with hardener 951, 10-12 parts by weight of hardener are added to 100 parts by weight of casting resin F. As with casting resin D, there is an exothermic reaction and large amounts should not be mixed. At normal temperatures the pot life of the resin hardener mix

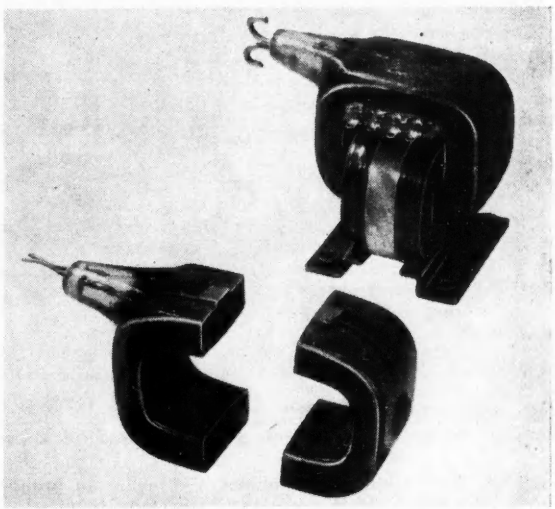


Fig. 4. Pulse transformer embedded in Araldite casting resin B
(By courtesy of Aircraft Transformer Co., U.S.A.)

is about 45 minutes and setting time is about 24 hours at 20°C. As with casting resin D, the application of heat will shorten the setting time, the times and temperatures being as for casting resin D.

As a hot setting casting resin using 40-45 parts by weight of hardener 901 to 100 parts by weight of casting resin F, a liquid of low viscosity at 100°C is produced. At this temperature the pot life is over four hours. Due to the very low viscosity of this mixture and the fact that it does not contain any solvents, it is particularly suitable for the embedding and impregnation of very fine windings. A double process is recommended for the potting of finely wound parts, consisting of an initial impregnation using casting resin F with hardener 901, and after curing, the impregnated winding is potted in casting resin B and silica sand. This technique permits the use of the most suitable resin for each purpose.

Flexible Casting Resin 33/896

Although casting resin B meets the requirements of most users and is in fact used for potting current transformers which embody as much as 2 600lb of resin, it was felt that

there was a need for a flexible casting resin which would retain its flexibility throughout the recommended temperature range of the resin. Furthermore, as it is not practical for the resin manufacturer to know the degree of flexibility required for each component, it seemed advisable that the resin should be so made that the user could vary the degree of flexibility by varying the proportions of the component which imparts the flexibility.

This development work resulted in the formulation of experimental resin 33/896, which is a three-part resin of which component B imparts the flexibility. The higher the proportion of component B, the more flexible is the final product. The ratio of A to B should not, however, exceed 3 : 2 and to every 100 parts by weight of component A, six parts by weight of component C must be used. Typical formulations would therefore be:—

100	parts	Component	A		100	parts	Component A
75	„	„	B	*or*	150	„	„ B
6	„	„	C		6	„	„ C

In use, component B is melted and added to component A. The two are mixed and held at a temperature between

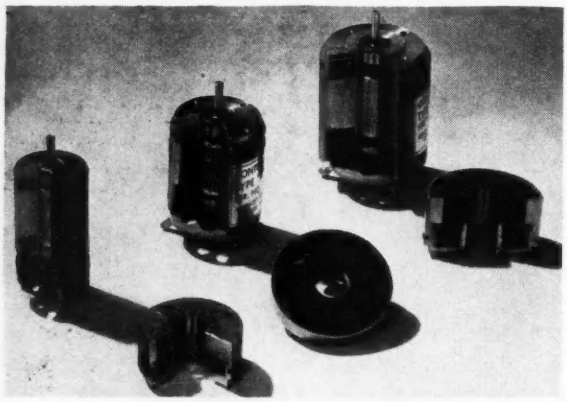


Fig. 5. Servo motors. Laminations bonded with Araldite 15, potted in Araldite casting resin B
(By courtesy of Kearfott Co., U.S.A.)

60° and 80°C until free of bubbles. The higher the proportion of component B used, the higher the temperature required to remove the bubbles. The necessary amount of component C is then added and carefully, yet thoroughly, stirred in. The mixture may then be cast, and since none of the components is readily volatile, vacuum methods of casting may be used. The pot life and curing times of the mixture are as follows:—

Parts of Component B per 100 parts					
Component A ..	25	50	75	100	150
Pot life at 70°C ..	20 min	35 min	70 min	2 hr	4 hr
Curing time at 100°C	1 hr	3 hr	3 hr	3 hr	5 hr

The final cured product will retain its flexibility up to a temperature of about 180°C but it should be noted that the higher the proportion of component B, the more flexible will be the final product, but smaller quantities of component B give a higher sheer strength and better water resistance.

This material may also be used as an adhesive where its properties of elasticity makes it particularly suitable for joining together materials which have widely different thermal coefficients of expansion, particularly if one of the materials is of a brittle nature. Among materials which have been satisfactorily bonded using this adhesive are diamond grinding wheels to moulded phenolic backing pieces and glass to metal.

When used as an adhesive it is necessary to add a filler to the resin mix in order to prevent it from flowing out of the glue line. It has been established that aluminium powder makes a suitable filler, about ten parts by weight of aluminium powder being used for every 100 parts by weight of component A, but many other materials are equally suitable. The pot life of the mix at room temperatures varies from two to four days according to the proportions incorporated of the medium used to impart flexibility.

Expanded Casting Resin 33/912

Resins which may be foamed or expanded in situ are finding applications both as potting compounds and also as structural materials. In the latter instance, they are foamed between metal sheets and in filling up the gap between the sheets also adhere strongly to them. If it is not intended to adhere to the metal surrounds, as for instance in normal casting techniques, the sides of the mould should be coated with silicone mould release agents as previously described.

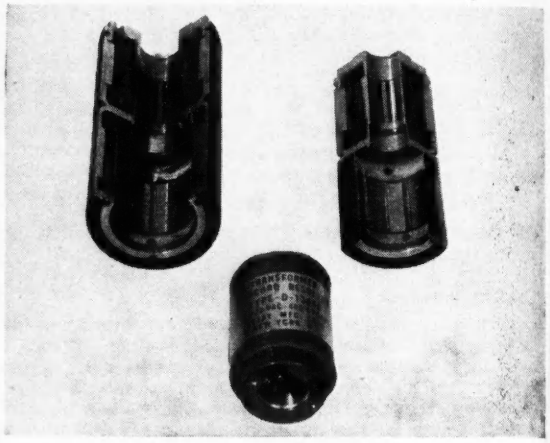


Fig. 6. Rotary Transformer.—Laminations bonded with Araldite 15, potted in Araldite casting resin B
(By courtesy of Ketay Manufacturing Co., U.S.A.)

The material is supplied as four components:—

Component A: The resin—a viscous liquid.
„ B: The hardener—a white crystalline powder.
„ C: The expanding agent—a crystalline powder.
„ D: The accelerator—a brown liquid.

One hundred and eighty parts by weight of component A and 63 parts by weight of component B are first mixed and maintained at a temperature of 100° ± 2°C for one hour. The material is then cooled to 50-55°C and one to ten parts (according to the amount of expansion required) of component C is added, followed by two to four parts by weight of component D. The mixture remains usable for at least one hour at this temperature, but as the mixture ages, so the density of the product from it increases. If, however, the mixture is immediately poured into a *cold* mould, it has a pot-life of approximately 24 hours. This will, of course, be affected by the heat capacity of the mould and the quantity of mixture involved. The expanded product is then produced by placing the mould in an oven so ventilated that the poisonous fumes evolved can be dealt with adequately. The oven should be at 80°C and the mould should be maintained at this temperature for three hours. If the heat resistance of the cured product is of importance, the mould should then be placed in an oven at 180°C for one hour.

The density of the foam is influenced by:—

(i) The proportion of component C added.

(ii) The proportion of component D added.

(iii) The quantity of material to be expanded.

(iv) The shape of the mould.

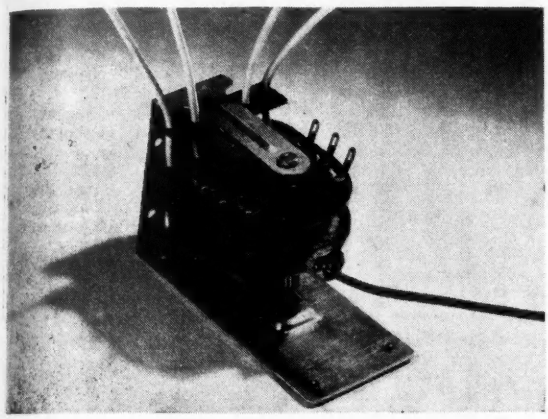


Fig. 7. Fly-back Transformer. Potted in Araldite casting resin B
(By courtesy of Todd-Tran Corporation, U.S.A.)

The effect of the various factors are:—

(i) Component C is the expanding agent, the more of it used the lower the density of the product.

(ii) Component D is the accelerator. For a successful product, the quantity of accelerator added should be such as to produce a reasonable viscosity, as expansion takes place, and then to gel when the maximum expansion has been reached. If gelation takes place before maximum expansion has been reached, the product will be much denser than expected, the bubbles will be very small and cracks will probably appear. If, on the other hand, gelation takes place after maximum expansion, the foam will collapse and the surface will be covered with craters.

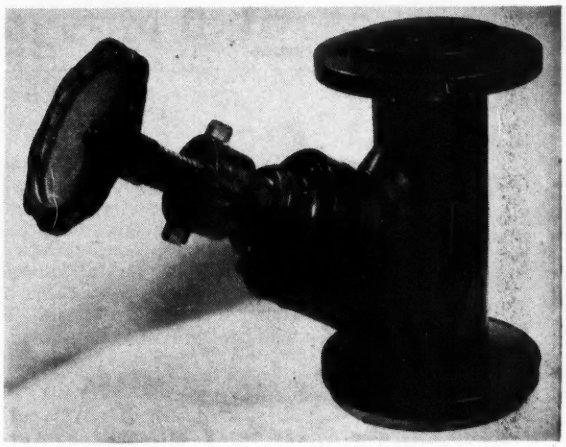


Fig. 8. Valve for chemical plant cast in Araldite casting resin B. The bore of the valve is 4 in.

(iii) The accelerating action of component D is exothermic and, generally speaking, the larger the amount of material to be expanded the smaller is the proportion of component D that should be used.

(iv) The shape and size of the mould has a very marked effect upon the density and texture of the expanded product. The more intricate and restricted the mould, the denser the product. If the mixture used for the production of an expanded product with an S.G. of 0·15 is expanded in a solid mould with a cavity ¼ in. wide by 6 in. long by 2 in. deep the specific gravity will be 0·5. Sometimes it is desirable to reduce the amount of component D for a restricted mould and in the above case, a reduction from 4 to 2½ grams reduces the specific gravity to 0·4.

Expansion of the resin is caused mainly by the evolution of nitrogen but a small amount of hydrogen cyanide is also given off. Hydrogen cyanide is a poisonous gas and precaution should be taken to provide adequate ventilation during expansion and curing. Furthermore, if any process involves the machining or slicing of the expanded material,

TABLE 3
Electrical Properties of Araldite Casting Resins

	TEST METHOD	CASTING RESIN B	CASTING RESIN D	UNIT
Permitivity or dielectric constant	ASTM D150–47T			
60 c/s		3·8		
10^3 c/s		3·65		
10^6 c/s		3·62	3·76	
3×10^9 c/s		3·09		
10^{10} c/s		3·01		
Loss angle tan δ	ASTM D150–47T			
60 c/s		0·0017	0·015	
10^3 c/s		0·0024		
10^6 c/s		0·019		
3×10^9 c/s		0·027		
10^{10} c/s		0·022		
Dielectric strength (⅛ in.)	ASTM D149–44	400		volts/mil
Diffusion constant	ASTM D697–42T	1·0	1·1	
Surface resistivity	ASTM D257–49T	$>3{\cdot}8 \times 10^{13}$		ohms
Volume resistivity	ASTM D257–49T	$> 10^5$	6×10^{14}	ohms
Arc resistance time	ASTM D495–8T	50–180		seconds

TABLE 4

Chemica Resistance of Araldite Casting Resin B

TEST MEDIUM	CONCENTRATION	TEMP. °C	RESISTANCE	DURATION OF TEST
Acetone	100%	20	N.R.	
Benzene	100	20	R	6 months
	100	80	R	6 months
Distilled water	—	20	R	12 months
		100	L.R.	3 months
Ethyl alcohol	100	20	R	6 months
	100	80	N.R.	
Formic acid	100	20	R	6 months
Glacial acetic acid	100	20	R	6 months
Hydrofluoric acid	100	20	R	
Hydrochloric acid	10	20	R	6 months
	10	100	R	6 months
	100	20	R	6 months
Nitric acid	100	20	N.R.	
Potassium permanganate	6g/100g water	20	R	3 months
Oil (mineral)	100	20	R	12 months
Sodium chloride	1	20	R	6 months
Sulphuric acid	10	20	R	6 months
	50	20	R	6 months
	96	20	N.R.	6 months
Trichlorethylene	100	20	N.R.	

N.R. Not resistant. R. Resistant L.R. Limited resistance.

the presence of hydrogen cyanide within the cells should be borne in mind.

Impregnating Resin 33/915

Although casting resin F, when used with hardener 901, is of such a viscosity that it is suitable as an impregnating resin, it suffers from the disadvantage of a relatively short pot life and must be handled at an elevated temperature. In order to overcome these difficulties a new impregnating resin which has a life of about 14 days and can be used at room temperature has now been developed. If 50 per cent of the contents of a container of resin and hardener are replaced every day, it is clear that a mixture having a usable life of one week would, due to replacement, ensure an indefinite pot life. The other basic necessities were a low viscosity and absence of solvents, both of which characteristics are found in this resin.

Fig. 9. A 12 ft. high current transformer casting in Araldite casting resin B
(By courtesy of Oerlikon, Switzerland)

Impregnating resin 33/915 is the number given to this experimental product which is offered as a two-component material, component A being a golden-brown liquid and component B a white crystalline flake. To mix, 100 parts by weight of 33/915A is heated to 60°-70°C and 35 parts by weight of 33/915B stirred in until a homogeneous solution is obtained. The mixture is then cooled and is immediately ready for use.

After impregnation, which takes place in a conventional manner, the resin should be cured for three hours at 120°C followed by about ten hours at 140°C. It is important not to exceed 120°C for the first two hours or the curing may be exothermal. Early indications suggest that this material is also suitable for the impregnation of porous metal castings.

Other New Products

One of the new products which does not come in the category of a casting resin is a hot setting filler This is likely to have a considerable use in the motor vehicle industry as an alternative to lead-tin solders for the filling of weld channels, etc., during the manufacture of vehicle bodies. Like the flexible casting resins, the filler has been designed (at the request of the motor industry) to possess flexibility in order that it shall not crack during relative movement of the panels being filled.

The filler is supplied in three parts which, after mixing are of a similar consistency to that of putty. It remains usable for about three days but is usually freshly mixed each day. Application is most easily carried out by the fingers but several alternative methods are in course of being evaluated. After the filler has been applied it is cured for 40 minutes at 130°C, a curing cycle which has been evolved to suit the conditions prevailing in most paint ovens used in the motor industry. One of the outstanding properties of this material is that when applied to a vertical surface no movement takes place during the curing cycle and the filler remains exactly where it is placed. After curing it is cut down and dressed, and then painted at the the same time as the remainder of the body. Of equal importance to this lack of flow during the curing cycle is the fact that the temperatures applied when stoving synthetic paints do not cause any further movement in the filler. Other features of this filler are that it is considerably cheaper and lighter than solder. It is not expected, moreover, to exercise any deleterious effect upon the health of operators engaged in its application, a further factor which helps to make this filler attractive to the motor industry.

It should be noted that Araldite resins, particularly casting resins, possess properties which are of great interest to the chemical engineer as well as to the electrical engineer. Table 4 shows the chemical resistance of casting resin B which is already being used very extensively for making valves, taps, etc.; the fact that it machines very easily increases its usefulness.

From these notes it will be seen that the development of the range of epoxy resins is now taking place at a fairly rapid rate. In addition to the materials already mentioned several other products are now undergoing tests before being offered to industry.

An A.C. Voltage Stabilizer

By R. G. Ackland*, B.Sc., A.Inst.P.

A motor-operated A.C. voltage stabilizer is described which provides a constant output voltage irrespective of wide variations in input voltage, load current, power factor or line frequency. No wave form distortion is introduced. As normally used the stabilizer maintains the output voltage at 230V ± 1 per cent with loads up to 9kVA and input voltages between 197 and 250V, but if desired it may be modified to control the output to within smaller limits, or to accommodate larger loads. The maximum correction time is 6·7 seconds, i.e., the correction rate is 8V per second for the input range 197-250V. A safety device is included which will isolate the controlling circuits within the stabilizer and virtually connect the load direct to line if failure of a component should cause the output voltage to vary from the desired value by more than a preset amount.

WHILE it is true that the correction time of a motor-operated A.C. voltage stabilizer is large compared to that of a resonant transformer type, the latter cannot normally be used where frequency variations are encountered, where the waveform must be kept free from distortion, or where ratings greater than 5kVA are required. For many applications, the longer correction time of the dynamic stabilizer is not a disadvantage.

Although motor-operated Variac type stabilizers have been described recently by Collinge and Marsham[1] and by Long[2], it is believed that the stabilizer to be described will be of interest because of its relatively large power rating, and also because of the simplicity of the voltage control unit, which contains only one electron tube (a voltage regulator). In the form described, the stabilizer is intended to provide a constant output voltage, and information is given showing how the load-carrying capacity, the range of input voltage that can be accommodated, and the limits within which the output voltage can be maintained, may be modified to suit particular requirements.

Description of Circuit

A block diagram of the circuit is shown in Fig. 1(a). An adjustable voltage from a Variac is injected into the active line, through a transformer. If one winding of this transformer is connected between the brush and a tapping on the Variac, the voltage will be such as to oppose the line voltage if the Variac brush is to one side of the tapping, and to boost the line voltage if the brush is to the other side. The total range of the correcting voltage will depend on the ratio of this transformer, while the relative amplitudes of the opposing and boosting voltages will depend on the position of the Variac tapping. Thus with a centre-tapped Variac, connected to give a total of 270V across its winding, and a 1:1 correcting transformer, the output voltage may be adjusted to 230V for any input voltage within the range 230 ± 135V. By increasing the transformer ratio, the voltage correction range may be reduced and the current-carrying capacity increased proportionately. With a transformer having a ratio of 5:1, for example, the voltage range would be nominally ± 27V, and, for a 2kVA Variac, the current rating would be approximately 40A.

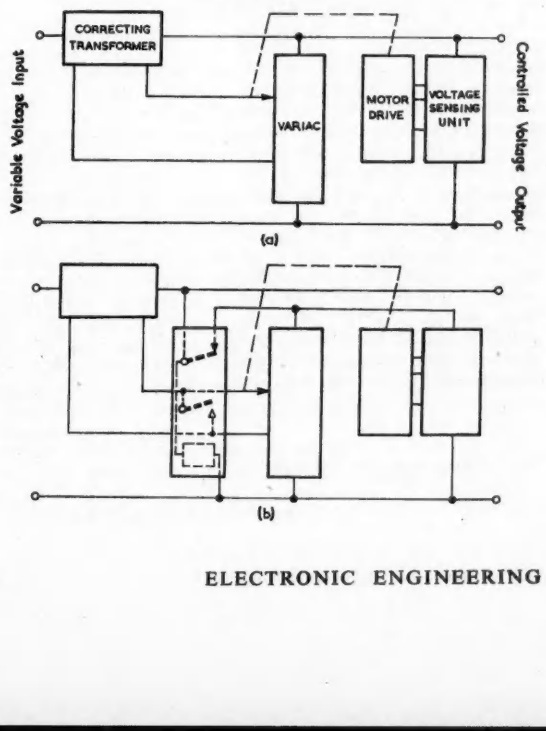
In the stabilizer described in this article a transformer having alternative ratios 155:30, 25 or 20 is employed, and the 2kVA Variac is tapped at turn No. 158 (total 256). For a 230V output this arrangement allows of alternative input ranges 197-250V, 203-247V, or 208-244V, at maximum output currents of 40, 49 or 63A respectively.

Automatic operation of the Variac is effected by a small reversing motor which is controlled by a voltage-sensing unit connected to the output side of the correcting transformer. To ensure that they operate at their correct voltage ratings, the Variac and its associated controls are also supplied from the output side of this transformer. The main winding and brush circuits of the Variac are protected by fuses. It would appear that failure of the brush circuit fuse would result in a dangerously high voltage appearing across the primary of the correcting transformer, but in a transformer having the correct power rating, saturation of the core limits this to about 400V. For the same reason, the maximum voltage likely to appear across the Variac, should it become isolated from its 230V supply, is limited to about 350V.

Failure of a protective fuse or of a component within the stabilizer could result in a relatively large change in the output voltage. Fig. 1(b) is a block diagram showing the addition of a safety device to isolate the controlling circuits and to short-circuit the primary of the correcting transformer should the output voltage vary from the desired value by more than a preset amount. Short-circuiting of the transformer primary virtually results in connexion of the load direct to line.

Fig. 2 gives details of the wiring between various components of the stabilizer; Figs. 3 and 4 give the complete wiring diagrams of voltage-sensing and motor-drive units and the under/over voltage safety unit.

Fig. 1. (a) Block diagram of Stabilizer. (b) Block diagram with added safety circuit



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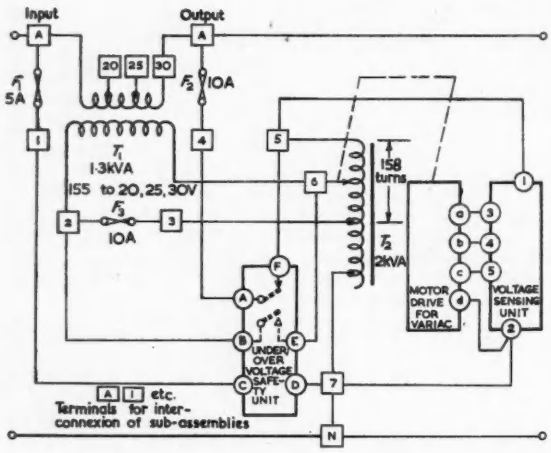

Fig. 2. Wiring diagram of complete stabilizer

Voltage-Sensing Unit

The voltage-sensing unit operates as follows: the output voltage from the stabilizer is rectified and fed into a bridge circuit having a voltage regulating tube in one arm and a moving-coil relay as a detector. The moving-coil relay *A* (Fig. 3) operates through one or other of two telephone type relays *B* and *C* to control a reversing motor which drives the Variac. To ensure stability, resistors R_4 and R_5 of the ratio arms of the bridge are of the wire-wound type, and a wire wound potentiometer VR_1 is included to enable adjustments to be made to the balance point of the bridge and hence to the output voltage of the stabilizer. Originally a VR150 was used as the reference voltage tube, but this was discarded because of its instability and temperature coefficient; because of one or other of these factors, most of the VR150 tubes tested were found to be worse than is suggested in the literature[3,4]. The QS150/15 (English Electric Valve Co. Pty. Ltd.) which was finally adopted, has been found to be very satisfactory. Use is not made of the special ignition electrode in this tube because the voltage across the bridge (300V) is sufficient to ensure ignition without it.

By varying the value of resistor R_2 the sensitivity of the detector relay (*A*) circuit can be altered. Because of the effect of the detector current on the bridge circuit, the maximum sensitivity (smallest control range) that can be obtained, when $R_2 = 0\Omega$ is $\pm 0{\cdot}2$ per cent, and the overall response of the voltage control unit is sufficiently fast to enable the output voltage to be held within these limits without hunting if desired. To maintain the output voltage within such narrow limits would, however, normally result in almost continual operation of the control unit with consequent increase in wear in the relays, motor and Variac bearings, and in the Variac windings and collector brush. For the purpose for which this stabilizer was developed (to supply the furnaces of high-sensitivity creep-testing machines) and for many other applications $\pm$ 1 per cent is adequate, and is achieved with the component values shown in Fig. 3.

Sparking at the contacts of relay *A* on opening is eliminated by capacitors C_2 and C_3, while resistors R_7 and R_8 prevent welding on closing.

The return leads of the energizing coils of relays *B* and *C* are connected into the ratio arms of the voltage-sensing bridge circuit in such a way as to modify the balance point when current is passing in a relay coil. When the voltage to be regulated is high, relay *B* is energized, with the result that the voltage at the tapping on VR_1 is reduced. Therefore, once relay *A* makes contact on either side, its coil is biased so as to increase the contact pressure. This not only ensures positive anti-chattering contact, but also makes it possible for the output voltage of the stabilizer to be returned to the centre of the control range whenever it reaches one of the limits, rather than to be merely prevented from exceeding that limit. This results in the output voltage being held near the centre of the control range for a greater percentage of the time, with consequent reduction in the frequency of operation of the control unit. The correct values for R_3 and R_6 depend on the sensitivity of relay *A*, but they must also allow for any overshoot present in the motor drive on the Variac; they can be calculated for any set of conditions, but as the equations involved are complex, it is much simpler to determine them experimentally. In the present case $R_3 = 0\Omega$, because when relay *C* is energized the effective internal impedance of the D.C. supply (MR_1 and C_1) is just sufficient to produce the desired voltage reduction at VR_1. If the sensitivity of relay *A* were to be reduced, R_3 and R_6 would have to be increased and *vice versa*. In the latter case, because R_3 cannot be reduced below zero, it would be necessary to return relay *C* to a tapping at the lower end of the ratio-arm network in order to reduce the effect of the internal impedance of the voltage supply on the bridge when relay *C* is energized. In the extreme case, i.e., when no biasing is required, relays *B* and *C* should both be returned to R_6, the approximate value of which should be 240Ω.

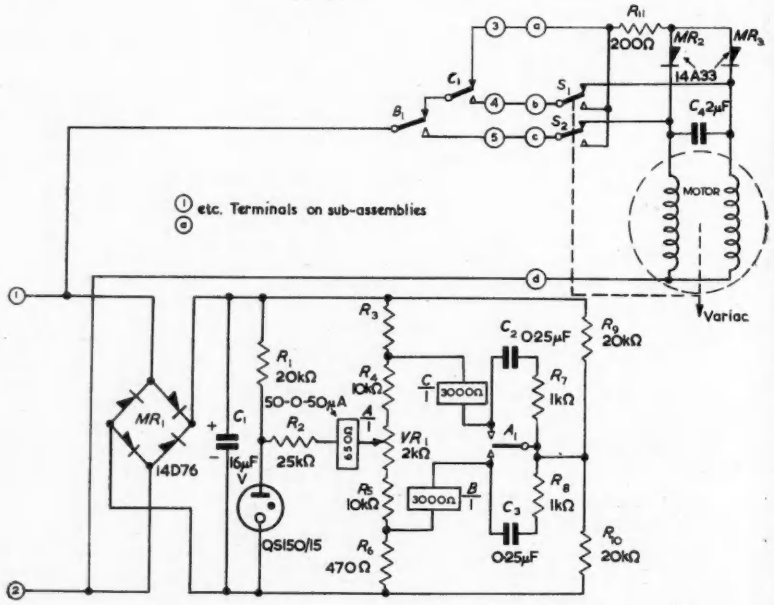

Fig. 3. Voltage sensing and motor drive circuits

Motor Drive

The Variac driving motor is of a small capacitor type with built-in gear box giving a final shaft speed of 8 R.P.M. These motors are readily obtainable, as they are of a type commonly used to drive the balancing mechanism of certain makes of potentiometric temperature recorders and controllers. The Variac is driven from the final shaft through a simple Oldham type universal coupling, full traverse being achieved in 6·7sec. Owing to the inertia of the rotor, which normally would result in an intolerably large overshoot of the Variac, braking is necessary. This is accomplished by passing D.C. through the windings when they are not energized by A.C. The wiring to the motor relay and limit switches is so arranged that, by using two half-wave rectifiers MR_2 and MR_3 with a limiting resistor R_{11}, the desired effect is achieved. With D.C. having approximately the same ohmic heating effect as the A.C. normally passed through the motor windings, the overshoot is reduced to about 3 degrees on the final shaft, which is equivalent to $2\frac{1}{2}$V on the Variac. For a correcting transformer ratio of 5:1 this corresponds to 1/2V, or approximately 0·2 per cent, in the output.

Although the limits set by overshoot in the drive are of the same order as the best obtainable from the voltage-sensing unit, it is possible to hold the output voltage within

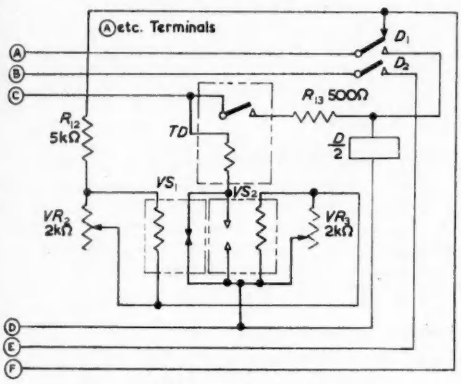

Fig. 4. Under/over voltage safety unit

these limits, because, when "inching," the motor does not attain full speed and therefore does not overshoot to the same extent. Under these conditions, biasing of the relay *A* should be reduced very nearly to zero.

Under/Over Voltage Safety Unit

The voltage-sensing device in the under/over voltage safety unit could well be a simple type of voltage sensitive relay having a sensitivity of about ± 5 per cent. As, however, no suitable relays were readily available, two Sunvic hot-wire vacuum switches have been used, one having contacts which open as it heats up and the other having contacts which close. By adjustment of the shunt rheostats VR_2 and VR_3 (Fig. 4) it is possible to set these switches to operate at any desired voltages, e.g., 220 and 240V respectively. Through an adjustable time delay switch, the vacuum switches control the relay *D*, the upper contacts of which arrange for the isolation of the control circuits within the stabilizer, and the lower for the short-circuiting of the correcting transformer primary. The time delay switch *TD* is included to prevent the stabilizer being rendered inoperative by short-duration voltage fluctuations outside its normal range or by the delay involved in starting up an automatic auxiliary generator in the event of failure of the main supply. Because it would be possible for the output voltage of the stabilizer to drop below the limit necessary for positive operation of this time delay switch, the supply for its heater is taken from the input side of the stabilizer where the voltage is not likely to drop below about 190V except in the event of a complete failure of the line. Resistor R_{13} is included to prevent large currents flowing in circuit *A* to *C*, which is across the secondary or heavy current side of the correcting transformer, should the lower contacts on relay *D*, which short-circuit the primary side of this transformer, fail to close.

Assembly

Fig. 5 gives a general view of the complete stabilizer. For its power rating it is a small unit, its dimensions being approximately 10 by 12 by 24 inches. The voltage sensing and under/over voltage safety panels, the Variac connexions and the motor drive are clearly seen.

Performance

As the voltage-sensing unit is in effect a controlling voltmeter which holds the output voltage of the stabilizer within set limits, the output voltage will be affected by variations in load, power factor or frequency, only to the

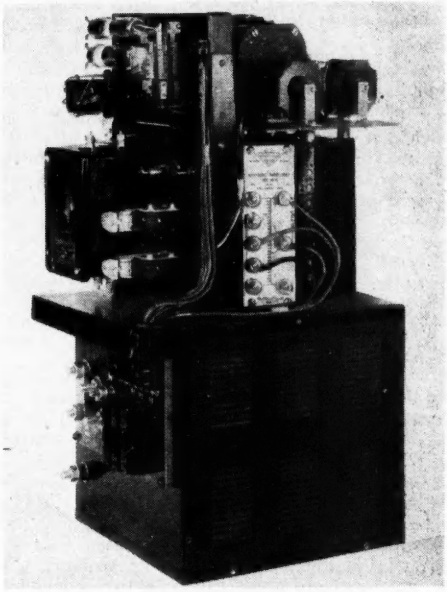

Fig. 5. The complete stabilizer with covers removed

extent to which the sensing unit is affected. Simple changes in load or power factor will have no effect, but, because the voltage-sensing unit actually controls the peak value of the output voltage, the R.M.S. value of the latter will be affected if there are changes in the peak factor of the voltage waveform. Significant changes in voltage waveform with varying loads are not normally experienced on supply lines, but they could be encountered in small auxiliary generating sets. From the component values shown in Fig. 3, it can be calculated that a deviation in frequency of a normal 50c/s supply by plus or minus 5 cycles would tend to produce a change of approximately plus or minus 0·33 per cent in the value of the voltage across C_1 and the bridge circuit, and hence, to correct this, the output voltage of the stabilizer would be automatically reduced (or increased) by 0·33 per cent. It can therefore be said that the stabilizer is virtually unaffected by changes in frequency.

Actual performance tests carried out on the stabilizer with equipment which allowed the input voltage, frequency, load and power factor to be varied independently, within the limits 200-250V, 46-54c/s, 0-5kVA, and 1·0 leading,

respectively, have confirmed the above conclusions as to its performance. As a check on its mechanical reliability, it was also given an accelerated cycling test of 250 000 operations over the range 230V ± 2 per cent, after which it was still operating satisfactorily. There was no evidence of sticking of relays or of contacts, or of wear of the Variac winding, brushes or central shaft (the central shaft bearings were lubricated with a smear of graphited grease before assembly).

Acknowledgement

The author is indebted to the Chief Scientist, Department of Supply, Australia, for permission to publish this article.

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A Triode F.M. Discriminator

By I. G. Baxter*, B.Sc., A.R.C.S.

A triode valve is used as a frequency modulation discriminator, in a simple circuit where it functions as a gated rectifier. The output voltage changes linearly with carrier frequency over a useful range, but the output is also proportional to changes in amplitude of the carrier waveform.

THERE is a category of phase sensitive rectifier in which triodes are used in push-pull fashion[1,2]. According to whether the input signal is in or out of phase with a reference voltage, so do the valves conduct unequally, thereby determining the amount and polarity of the output. The present arrangement bears a general resemblance to such systems, being based on the use of a triode as gated rectifier. It differs, however, in being single ended, with the phase of the signal voltage varying continuously relative to the reference voltage, instead of being either 0° or 180°.

Principle

The working of the circuit may be followed by considering the action of a triode connected as a shunt rectifier to a source giving a trapezoidal waveform. If the grid is earthed, the anode will assume a mean voltage nearly equal to the peak amplitude of the input (Fig. 1(a)). On the other hand, if the valve is cut off at a certain point in each cycle with negative pulses at the grid, then rectification will take place as if with an input of smaller amplitude, and the mean level attained by the anode will be less (Figs. 1(b) and (c). By causing the instant of cut-off to vary with frequency, the rectified output can be made dependent upon frequency, and the device will function as a frequency modulation discriminator. It will, of course, give an output that varies with the amplitude of the input as well.

Practical Circuit

In practice, it has been found that a tolerable performance can be obtained from a circuit working on the above principles, but operated with sinusoidal waveforms. So far as the signal at the anode is concerned, the requirement is simply for the flanks of the waveform to be linear over a reasonable range; this is fulfilled by a sine wave, in which the straight portions extend over about one radian. In the case of the gating signal at the grid, the use of a sine wave is in principle less satisfactory, for the rounded crests preclude a well defined switching action.

The arrangement of the discriminator is shown in Fig. 2. A tank circuit, in combination with a series capacitance ($C + C_s$), is the load of a preceding driver stage, and serves also as a phase shifting network for providing the reference voltage at the grid. This potential arises from the load current flowing in $C + C_s$, and the grid is allowed to generate its own bias by local rectification. The component values shown are not particularly critical, nor is the type of valve. The amplitude of the grid voltage is the factor which seems to have most bearing on the performance, and an optimum value for C can be found experimentally. The calibration shown in Fig. 3 relates to the circuit of Fig. 2.

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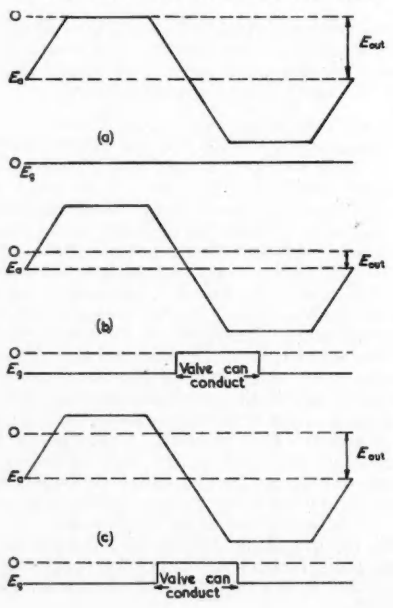
Use with Capacitance Pick-up

The discriminator has been used in conjunction with an oscillator whose frequency was modulated by a capacitance pick-up. The oscillator described by Gouriet[3] was employed, as it is simple, stable, and insensitive to lead capacitance; the output was amplitude stabilized and fed direct to the discriminator.

Conclusion

The working of the discriminator has not been rigorously

Fig. 1. Trapezoidal waveforms of discriminator



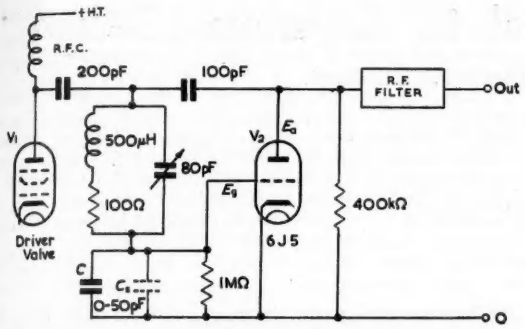


Fig. 2. Triode discriminator circuit (C_s represents the stray capacitance—about 20pF). Operating frequency 0·8 Mc/s

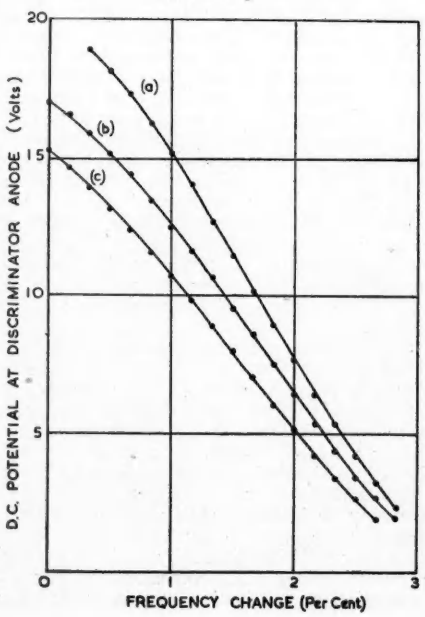
analyzed, but it accords with general expectations. By neglecting adverse factors one can make a crude theoretical estimate of the performance, but the measured characteristics fall rather short of this ideal.

Consider, for example, the circuit of Fig. 2, operating with an R.F. signal of 50 volts amplitude (peak) at the anode of the discriminator, and having $Q = 20$ for the tank circuit. The slope of the linear portions of the waveform will be approximately 50 volts/radian, and the phase shift of impedance with frequency will be nearly linear over a range of 1 radian, corresponding to a frequency change of about 2½ per cent. If the gating action occurred in an ideal manner, with the point of cut-off falling on the straight part of the waveform, and subject to a phase shift with frequency at the rate just given, it follows that the rectified output voltage would change at the rate of about 20 volts/1 per cent frequency change. By contrast, the measured performance is about 7·5 volts/1 per cent (Fig. 3). This result was obtained with the load resistor of the discriminator returned to cathode; ideally it would be connected to a positive bias, to extend the working range by permitting rectification during the negative going half cycles.

Fig. 3. Calibration of discriminator

E_a peak = 50V E_g peak ≈ 10V

(a) C = 0pF (b) C = 25pF (c) C = 47pF



The frequency response has not been measured, but it should be adequate for rates of change of frequency up to some kilocycles per second, and could presumably be raised slightly by using a smaller coupling capacitor or load resistor for the discriminator.

A useful feature of the system is that it contains merely a single tank circuit which serves both as a load for the driving amplifier and as a phase shifter for the discriminator. Setting-up is exceedingly easy, and a fair range of carrier frequencies can be accommodated by simply retuning the tank circuit.

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A High Stability Variable Frequency Oscillator for Centralized Transmitter Drive Units

Under International Telecommunications Union regulations, the frequency of medium and high power radio transmitters in the band 4-30Mc/s must be kept within 0·003 per cent of its nominal value over periods of twenty-four hours. In order to achieve the necessary degree of frequency stability, it is usual to resort to crystal control. This has the disadvantage that it is necessary to obtain new crystals whenever channels are reallocated. To overcome this disadvantage, the Equipment Division of Mullard Ltd. have recently developed a variable frequency oscillator of exceptionally good stability, thus permitting continuous coverage of the short-wave broadcast band and avoiding the use of crystals altogether. The oscillator, in conjunction with suitable frequency multipliers and measuring equipment, therefore has considerable applications in the drive units of high frequency broadcast transmitters, civil aviation transmitters, and the radio telegraph and telephone links of Posts and Telegraph systems.

The construction of the High Stability Variable Frequency Oscillator has been made possible by the use of a precision variable capacitor in the tuned circuit. A stable inductor and its associated temperature compensating capacitors make up the rest of the frequency determining elements. The precision capacitors were originally designed to meet the need for a variable capacitor of outstanding reliability and long-term stability for use in communications equipment. Important features are: integral temperature compensation; exceptionally good capacitance repeatability and permanence; very low power factor; and excellent conformity to a straightline frequency law. In addition to the use of highly stable components, the oscillator is housed in a simple oven whose temperature is controlled to ±1°C. This precaution is adequate to keep frequency drift well within the prescribed limits of ±0·0003 per cent.

The high stability variable frequency oscillators are designed for rack mounting as part of a centralized transmitter drive unit.

The oscillator output, which is variable between the limits 1·0 to 1·7Mc/s, is passed through a tuned buffer amplifier to a frequency multiplier which will produce either the second (2-3·4Mc/s or the third (3-5·1Mc/s) harmonic of the oscillator frequency, as required. A final wideband power amplifier delivers an output of 0·5 watt into 70 ohms.

The Mullard high stability variable frequency oscillator should be of great use in centralized transmitter drive units, both in new equipment, where the convenience of continuously variable tuning is desired, and in older equipment where it is necessary to bring the frequency stability up to I.T.U. standards.

Minimizing Contact Potential in Apparatus Design

By E. C. J. Marsh*, B.Sc. (Lond.), F.R.I.C., F.I.M.

Unless apparatus can be hermetically sealed, serious consideration must be given to minimize contact potentials at bimetallic junctions. Judicious choice of metal coatings—electroplated, sprayed or "hot-dipped"—can materially assist in this direction, and thereby give increased flexibility to the designer. Useful guides are given in the Radio Components Standardization Committee's document RCS/1000, and in the Radio Industry Councils' specification RIC/1000 B. At the same time, the designer must not allow consideration of contact potential to exclude an appreciation of all the other essential quality requirements of metal coatings.

THE avoidance of excessive contact potential between the component metal parts of electrical communications apparatus has become of increased importance. This is particularly the case in those radio equipments from which higher performance is demanded from designs more compact in size and lighter in weight. Such units must function satisfactorily under conditions of exposure that cannot always be controlled, so that not only are fluctuations in temperature and humidity experienced, but other adverse influences including condensation of moisture, the incidence of salt laden and industrial atmospheres, and the deposition of dusts, are likely to be encountered. The complete enveloping of the functional parts of the equipment, or of the equipment itself, in a protective membrane is at present rarely practicable, and therefore metals and metal junctions must be chosen to resist the conditions likely to be encountered. This is by no means a simple requirement to satisfy in practice, especially when it is remembered that the fabricational needs of manufacture have to be met as well as the mechanical and electrical qualities of the design.

Confining consideration to the significance of contact potential between different metals in the assembly—and this is only one of several factors which demand attention —electrical designers in common with technicians in other spheres of engineering, have always given some general thought to this subject. The possibility of "battery action" under damp conditions between markedly dissimilar metals like copper and aluminium, and copper and zinc, has been appreciated. Thus bronze and brass inserts in aluminium and zinc alloy castings have been avoided where practicable. Again, with electroplated coatings, the sacrificial type of protection afforded to iron and steel by deposits of zinc or cadmium, which behave anodically, has been appreciated, in contrast with the blanket type of protection given by non-porous coverings of nickel (or nickel/chromium), which is cathodic to the ferrous base. In more recent years, however, electronic engineers have found it necessary to give more detailed attention to contact potential. To this end, the table (reproduced in Table 1) of potentials in sea-water against the saturated calomel electrode at room temperature given in the Inter-Services document RCS.1 000 and in the Radio Industry Council's Specification RIC.1 000B, as well as the table included in the latter as a general guide to metal-to-metal combinations which have been found satisfactory in practice, have proved invaluable. Guidance is also given in RCS.1 000 to the effect that the maximum potential difference should be limited according to conditions broadly defined as follows:—

(a) 0·25V when the conditions of service are such that the equipment is liable to wetting with salt water or is normally exposed to the weather;

(b) 0·50V for components or equipments that may be regarded as interior apparatus which may be exposed to condensation but not to contamination with salt; and

(c) No restriction for interior parts of hermetically sealed components or equipments.

Shortcomings may attend the lead given by these official documents, but it does represent major progress beyond the text-book table of the electro-chemical series of the metals which, not so many years ago, represented the only data available for engineers on this subject.

Laboratory corrosion tests can often be used to demonstrate the unsuitability of certain bimetallic junctions, and components or equipments returned from service due to premature failure sometimes show the disastrous results caused by the use in close contact of metals having a wide difference of contact potential. On the other hand, it is not always possible from artificial tests to establish that a combination, which theoretically should not be used, is actually detrimental, and again there are numerous examples in practice of wrong junctions giving excellent serviceability over long periods of time. There must exist good reasons to explain these discrepancies and generally they lie in the conditions obtaining in service, and/or the attention or lack of attention to other pertinent factors.

Where conducting contact is required between components, electroplating (or other method of metal coating such as hot dipping or spraying) is a practical way of eliminating or reducing the contact potential between adjacent parts. As most items need to be so coated for other reasons (protection from corrosion, reduction of contact resistance, maximum high frequency conductance, solderability), the economic aspect is unlikely to be significantly affected, and this affords an acceptable practical solution to the problem. In adopting it, however, it is most important that attention should not be given to the problem of contact potential to the exclusion of all other factors. The latter may conveniently be embraced in the expression of "quality of the electroplate coating." They include the general qualities of uniformity of distribution of the coating over the part, thickness of coating, density and freedom from porosity and discontinuities, and adhesion. Choice of the right metal coating in relation to the anticipated corrosive conditions as well as with respect to the contact potential aspect, and avoidance of mechanical mishandling after coating, i.e., no machining or filing, drilling or tapping, or other correction or fitting operations which would obviously produce discontinuities in the coating, is assumed.

Even when the most favourable metal combination is chosen and provided with best practicable commercial techniques, the engineer must be wary against assuming that perfection has been achieved. The extent of battery action at a bimetallic junction is dependent upon a number of factors in addition to contact potential. The latter and the resistance of the path determine the magnitude of the current flow and therefore the amount of corrosive action. Hydrogen may be liberated at the cathodic element, and if it adheres to the latter rather than becoming dispersed, the system may polarize, gradually building up resistance till the current stops, and corrosion therefrom ceases. Again, oxidation or passivation may occur at the anodic

* *Standard Telephones & Cables, Ltd.*

element, retarding or stopping the action. Further, chemical processes may follow the electro-chemical reaction, for example, the absorption of carbon dioxide, and insoluble compounds may be formed. If these are formed at the seat of the battery action, they may add resistance and fulfil a rôle in restraining attack; on the other hand, under conditions of, for example, heavy condensation, they may be produced in a more remote area or actually washed away from the junction, and thus play no important part in the course of the deterioration. Aeration, too, may complicate the process of corrosion due to differential oxygen concentration. In illustration of this, if two exactly similar pieces of iron are immersed in a dilute salt solution with a separating porous partition between them, and one section is aerated by bubbling air through the solution, a potential is set up and a current will flow from the unaerated to the aerated iron if they are connected by a conducting wire. In practice, complications can arise from such phenomena; for example, under "wet" conditions, it is evident that oxygen concentrations in crevices, e.g., clamped junctions, can be significantly different from those at the surface.

The table of contact potentials gives values for one set of conditions only, and it has to be assumed that the relative position of the metals under other conditions is the same, which is not necessarily true. The metallurgical and physical condition of the metals have their influence, e.g., grain size, hardness, surface condition, as well as metallographic aspects of eutectic, solid solution, compounds, disposition of impurities and the like. This emphasizes the need for quality control in the metals used, and in their fabrication into parts. The same stress can be laid upon the quality of metal coatings, particularly with reference to purity and freedom from inclusions.

In one application or another, practically all the metals are used in communications equipments, but those most used in the construction of apparatus and equipment are the steels and stainless steels, the copper rich non-ferrous alloys, especially brass, and aluminium and its alloys. Silver has to be included in contact potential considerations because it is an essential finish for high frequency conductance, and solder because it is an unavoidable joining material. The wide spread of potential of this range of metals is readily apparent from Table 1.

To some extent the range of metals employed is illustrated in Fig. 1 by a "drawer" type assembly for mounting in a radio receiver or transmitter cabinet. The

Fig. 1. Drawer type radio assembly with chassis in position
(By courtesy of S. T. & C.)

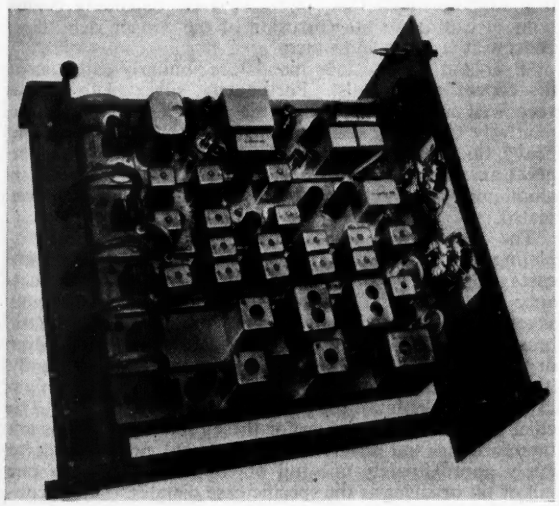


TABLE 1

Potentials Against Saturated Calomel Electrode in Sea Water at Room Temperature

MATERIAL	VOLTS
Magnesium and its alloys	−1·60
Zinc and its alloys :—	
Zinc die-casting alloy, B.S.1004	−1·10
Zinc plating on steel, D.T.D.903	−1·10
Zinc plating on steel, Chromate passivated, D.T.D.923	−1·05
Galvanized iron, B.S.729	−1·05
Tin-zinc alloy (80/20) plating on steel	−1·05
Cadmium and its alloys :—	
Cadmium-zinc solder, D.T.D.221	−1·05
Cadmium plating on steel, D.T.D.904	−0·80
Aluminium and its alloys :—	
Aluminium alloy casting, B.S./L5	−0·90
Aluminium alloy casting, D.T.D.424	−0·80
Aluminium alloy castings, B.S./L33, D.T.D.133	−0·75
Wrought aluminium alloy coated aluminium alloy, D.T.D.687	−0·90
Wrought aluminium, B.S./L4, L16, L17, L34, T9	−0·75
Wrought aluminium coated aluminium alloys, B.S./L38, L47, D.T.D.390, 546, 610	−0·75
Wrought aluminium alloys other than duralumin	−0·75
Duralumin type alloys, B.S./L1, L3, L39, 395, 396, T4, D.T.D.364, 464, 603, 646	−0·60
Irons and steels :—	
Non-stainless :	
B.S./S2, S6	−0·75
B.S./S3, T1, T45, Grey cast iron	−0·70
Stainless :	
12% chromium, B.S.61, 62, 85, D.T.D.161, 203	−0·45
High chromium, B.S./S80, D.T.D.60, 146, 185	−0·35
Austenitic, D.T.D.166, 171, 176, 189, 207, 211	−0·20
Lead and its alloys :—	
Lead	−0·55
Lead-silver solder (2½% Ag.)	−0·50
Tin and its alloys :—	
Tin-lead solders, B.S.219, Grades A and B	−0·50
Tinned steel, B.S./S20	−0·50
Tin plating on steel, D.T.D.924	−0·45
Chromium :—	
Chromium plating, 0·0005 inch on steel	−0·50
Chromium plating, 0·00003 inch on nickel-plated steel	−0·45
Chromium (massive, 99%)	−0·45
Copper and its alloys :—	
Brass, B.S.265	−0·30
Brass, B.S.249 ; Gunmetal, B.S.383	−0·25
Copper, B.S.899 ; Beryllium-copper, T.C.M. CuBe 250 ; Brasses, B.S.250, D.T.D.283 ; Bronzes, B.S.407, D.T.D.412 ; Nickel-silver, B.S.790 ; Cupro-nickel (70/30)	−0·20
Nickel and its alloys :—	
45% Nickel alloy, D.T.D.237	−0.25
Monel metal, D.T.D.10 ; Monel X	−0.15
Nickel-plating on steel, B.S.1224, Ni 85	−0·15
Silver and its alloys :—	
Silver solder, B.S.206, Grade C	−0·20
Silver ; Silver plating on copper	±0·00
Rhodium plating on silver-plated copper	+0·05
Platinum	+0·15
Gold (assay)	+0·15

base framework is of steel cadmium plated, while the individual chassis, and covers on the components mounted thereon, are of brass tin plated. The front panel is of steel, zinc plated and chromate passivated, and enamelled on the front face. Fig. 2 is another radio unit in which the main chassis, and that for the rotary transformer, are fabricated from aluminium alloy (unfinished). The components on these are mainly of brass tin plated. The castings of the transformer unit are aluminium-silicon alloy, chromate pickled and stove enamelled. The filter unit on the front of the equipment is of aluminium alloy, anodized and finished with black shrivel enamel on the face side. This also illustrates the effort made not only to keep the equipment cool, but to eliminate dust, which is one potential danger in promoting corrosion and loss of insulation.

Giving brief attention to electroplate coatings, it will be seen that zinc and cadmium are both anodic to iron and steel and that the contact potential of cadmium is much closer to that of steel than is that of zinc. The radio industry prefers cadmium as a protective finish for iron and steel, not only because it is less extensively attacked

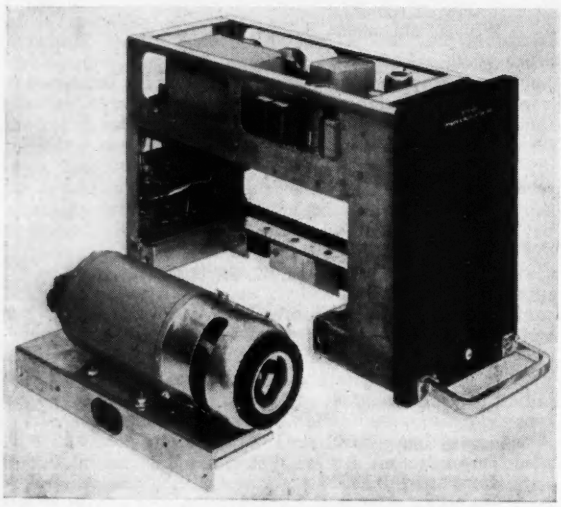


Fig. 2. Radio unit with blower removed
(By courtesy of S. T. & C.)

itself in many corroding environments, but also because it does keep the contact potential down towards the centre of the table, easing matters where the non-ferrous metal components have to be assembled to it. Thus the contact potential of cadmium is closely the same as that for the aluminium alloys, and only about 0·3 volts removed from those for tin and tin coatings, and soft solder. Zinc and cadmium do not really provide sound coatings on the copper-rich alloys, zinc on account of wide difference of contact potential, and cadmium for the same reason, as well as on account of its propensity for diffusing into copper at normal temperatures. Tin provides a satisfactory metal coating for these metals and, with its own contact potential of about 0·5 volts, which is not widely different from those for cadmium and aluminium, it provides a reasonable compromise as an electroplate or hot dipped coating for use in contact with cadmium or aluminium. When greater precision is necessary the copper-rich metals may be given a dual plating of tin followed by cadmium. The tin prevents diffusion of cadmium into copper as well as bridging the wide gap between the potentials of copper, brass and bronze, and those of cadmium or aluminium. There are of course instances when it is more appropriate to tin plate the aluminium for contact with a tin-coated copper-rich alloy, and this emphasizes the flexibility of approach to the problem. Again, if silver is insisted upon as the coating for the copper-rich metal, and contact has to be made with aluminium, there is no alternative to coating the latter with silver as well.

Zinc (as electroplate, metal spray, or hot dipped coating), of course, serves as the general purpose protective coating for iron and steel, and chromate passivating does prevent rapid whitening under damp conditions; tin/zinc alloy is an alternative. The other commonly deposited metals, viz. tin, nickel, and silver, are cathodic to steel, so that coatings of them must be continuous and thick enough to be non-porous to the environment in which employed, otherwise they accentuate corrosion at any discontinuities.

In the finishing of copper and the copper-rich alloys, tin is the logical choice for corrosion protection, being anodic without the contact potential of it being too widely different. On the other hand, nickel has been employed for years for telecommunications apparatus and actually still is specified in the Crown Agents specification for this purpose for export equipment. The reason for the use of

TABLE 2

Electrode Potentials of Aluminium Solid Solutions and Constituents*

SOLID SOLUTION OR CONSTITUENT	POTENTIAL VOLTS 0 IN. CALOMEL SCALE†
α(Al−Mg) (Mg_5 Al_8)	−1·07
Al+Zn+Mg (4% $MgZn_2$) Solid Solution	−1·07
β(Zn−Mg) ($MgZn_2$)	−1·04
Al−4% Zn Solid Solution	−1·02
Al−1% Zn Solid Solution	−0·96
Al−4% Mg Solid Solution	−0·87
α(Al−Mn) ($MnAl_6$)	−0·85
Aluminium (high purity)	−0·85
Al+Mg+Si(1% Mg_2Si) Solid Solution ..	−0·83
Al−1% Si Solid Solution	−0·81
Al−4% Cu Solid Solution	−0·69
α(Al−Fe) ($FeAl_3$)	−0·56
Al-Cu ($CuAl_2$)	−0·53
Silicon	−0·26

* *Data from Aluminium Research Laboratories.*
† *Measured in an aqueous solution of* $53gNaCl+3gH_2O_2$ *per litre.*
(From A.S.M. "Metals Handbook.")

nickel is really to preserve a white or pale coloured finish and to prevent the black sulphide tarnish that would otherwise occur on brass, copper and bronze. The nickel itself is well resistant to corrosion because of passivity, but it should be noted that, under severely corroding conditions, it can accelerate corrosion of the copper rich alloys because it is cathodic to them.

Silver and the precious metals are similarly cathodic to the copper rich metals. Fortunately, silver plate throws very well and is dense, and the copper rich metals are relatively corroding resistant themselves, so that the same heavy thickness is not required upon them as would be necessary upon iron and steel, and as is very essential on aluminium or zinc, when these metals have to be silver plated.

The zinc alloys and aluminium alloys need electroplating for radio communications equipment in many cases. Often a surface coating of high frequency conductance is essential and this means that silver, or copper plus silver, has to be applied. Again, many components of brass or copper which are already plated with either silver or tin have to be assembled to aluminium, and consequently it is desirable to have the same plating on the aluminium in order to eliminate the effect of contact potential. The chief finishes on aluminium for these radio applications are therefore tin and silver, and the general procedure is to apply approximately one mil of copper followed by one mil of tin or silver as the specific case dictates. Under con-

ditions of the damp tests normally specified for services and civil contracts, a total coating thickness of one mil will satisfy the conditions, but a thinner deposit will generally blister and promote rapid attack of the aluminium beneath the blisters. Under salt spray conditions the two mil thickness is generally found to be necessary to give immunity from attack.

The determination of contact potentials uses simple equipment, but in itself is complicated by subsidiary chemical reactions which may occur, so that to obtain stable reading of assured accuracy is somewhat difficult. The Royal Aircraft Establishment in this country have performed most work on the subject, and the values in Table 1 are largely based on their work. Other authorities have used other conditions, including different electrolytes. A recognized standard procedure is sought and research to establish values to an accuracy of perhaps 0·01V; those given to 0·05V are not always adequate when limiting a maximum difference of potential to 0·25V. Data upon the influence of alloying constituents would also be useful on the same basis, particularly in view of the disparity between alloys in the same group, e.g. duralumin and aluminium/managanese alloy.

In the case of alloys, it can be rather loosely stated that one of the alloying elements largely dictates the behaviour of the alloy and that generally speaking the electrode-potential of the alloy lies somewhere between those of the constituent metals. This is perhaps a dangerous statement to make on account of the complex metallurgical and physical problems which enter. It is to be remembered that in an alloy the constituents may lie side by side as an eutectiferous mixture. On the other hand, they may form a solid solution or a number of solid solutions, or again complications may arise because a series of chemical compounds are produced. To add to the complications, physical influences arise resulting from the history of the particular metal and its form, i.e., from rolling or drawing, casting or extrusion, and the influence of heat treatment, and finally there is the possibility of passivity being developed to some degree. All these factors have some influence which will vary according to the nature of the corroding environment.

The solders are eutectic mixtures and their contact potential lies between that of tin and of lead, the values of which are quite close together. Tin/zinc alloy is also a eutectic type, and in this zinc is the predominating factor giving a contact potential almost the same as that of zinc, but widely different from that of tin.

The number of aluminium alloys employed today is almost legion, and, as the electroplater is fully aware from experiences in the finishing of them, they have a number of peculiarities as shown by their response to cleaning and plating treatments. As a matter of interest, Table 2 shows data from the work of the Aluminium Research Laboratories of America showing the electrode potentials of some of the actual constituents in these complex alloys. These were measured in an aqueous solution of 53 grams of sodium chloride and 3 grams of hydrogen peroxide per litre at room temperature. From the point of view of the present subject, it will be noted that with high purity aluminium at −0·85V, a magnesium constituent raises this appreciably and that zinc does the same. On the other hand the aluminium manganese constituent gives a value the same as aluminium and it is significant that the 1¼ per cent manganese aluminium alloy is well known in industry as being the one aluminium alloy that has a corrosion resistance equal to that of aluminium itself. On the other side of the scale, silicon itself has the very low value of

TABLE 3

Electrode Potentials of Aluminium Alloys in 3 Per Cent Sodium Chloride Solution at Room Temperature against Saturated Calomel Electrode

ALLOY	COMPOSITION—PER CENT								POTENTIAL VOLTS
	Cu	Si	Mn	Fe	Mg	Ni	Ti	Zn	
High Strength	—	0·3	1·0	0·2	3·0	—	0·1	7·0	−0·94
Castings 3L5	2·8	0·7	—	0·8	—	—	0·2	13·5	−0·91
Airscrew Alloy X765	0·6	0·5	0·5	0·3	1·4	—	0·1	7·5	−0·89
7% Magnesium Alloy	—	—	—	—	7·0	—	—	—	−0·81
Castings D.T.D.424	2·0	4·5	0·7	0·8	0·1	0·3	—	0·2	−0·80
3½ Magnesium Alloy	—	—	—	—	3·5	—	—	—	−0·77
Wrought RR.77	2·1	0·3	0·5	0·4	2·8	—	—	5·0	−0·77
Aluminium Sheet L16	—	—	—	—	—	—	—	—	−0·76
Castings L33	—	11·5	—	—	—	—	—	—	−0·75
Sand or Die Casting D.T.D.133	1·4	2·1	—	1·1	0·2	1·3	0·1	—	−0·73
Aluminium-coated Dural	—	—	—	—	—	—	—	—	−0·73
Wrought RR.56	2·1	0·9	—	0·9	0·9	1·0	0·1	—	−0·70
Duralumin	4·0	0·7	0·6	0·7	0·6	—	—	—	−0·60

TABLE 4

Potential Differences (in volts) between Various Copper Alloys in Dilute Synthetic Sea Water*†

	RED BRASS	70–30 BRASS	MUNTZ METAL	ALUMINIUM BRONZE	30% CUPRO NICKEL	ALUMINIUM BRASS
Copper	+0·031	+0·047	+0·086	+0·048	+0·030	+0·053
Red Brass	—	+0·038	+0·043	+0·005	−0·012	+0·013
70–30 Brass	—	—	+0·013	−0·033	−0·011	0·00
Muntz Metal	—	—	—	−0·030	−0·042	−0·016
Aluminium Bronze	—	—	—		−0·017	+0·010
30% Cupro-Nickel	—	—	—	—	—	+0·027

* *H. L. Burghoff, "Corrosion of Metals," p. 100 (1946), American Society for Metals.*

† *Solution one-sixth the usual strength of sea water.*

−0·26V and the copper solid solutions and compounds are appreciably lower than aluminium itself.

These points do explain the corrosion behaviour and other phenomena experienced with the aluminium alloys. They give the reason why low magnesium alloys such as the Birmabright series have quite good resistance to corrosion, and why those having appreciable copper contents, such as Duralumin are relatively poor. They also explain why the 11-13 per cent silicon alloy which is a eutectiferous mixture can fail by "pitting" corrosion. These data also help to explain to some extent why in the electroplating of aluminium such wide divergencies of performance are encountered in passing the work through the pre-treatment solutions (caustic, acid, sodium zincate, etc.), and why differences of behaviour occur here not only with differing compositions, but also with forms of the same composition differing with respect to temper or heat treatment.

In regarding the values quoted in Table 2 it must be remembered that these have been determined in a rather different solution from that used for the electrode potentials in Table 1, which does affect the actual value but would not affect the relationship from one to another. In Table 3 more detail is given for the aluminium alloys from some of the work by R.A.E. and others, to further illustrate the points just discussed.

The dominating influences of a highly anodic element is also shown to some degree in the copper/rich alloys, i.e., by comparing copper with the brasses. The value for copper itself is − 0·18 and the 60/40 copper zinc brasses about − 0·30 with the lower zinc brasses of the order of −0·25.

TABLE 5

Electrode Potentials of Irons and Steels in 3 per cent Sodium Chloride Solution at Room Temperature against Saturated Calomel Electrode

METAL	COMPOSITIONAL—PER CENT			ELECTRODE POTENTIAL VOLTS
	CARBON	NICKEL	CHROMIUM	
Mild steel ..	0·23	—	—	−0·70
Grey cast iron	3·0	—	—	−0·70
Stainless steel	—	—	12·0	−0·45
Stainless steel	—	—	18·0	−0·35
Stainless steel	—	8·0	18·0	−0·20

Again in relation to the influence of zinc as an alloying element and the relative position of copper and the various brasses, Table 4 is reproduced from "Metals Handbook," p. 897 (1948). It shows the potential difference in volts between copper and various copper alloys measured in sea water diluted to one-sixth of the usual strength. Examining the figures along the first horizontal line, it will be seen that copper shows an increasing positive potential to red brass (85/15 or 90/10), 70/30 brass and Muntz metal (60/40), the zinc content increasing from 10 or 15 per cent in the first to 40 per cent in the third of these alloys. The influences of aluminium in aluminium bronze in the fourth column should also be noted, and the similarity of the aluminium brass in the last column with 70/30 brass.

With respect to the stainless steels a number of peculiarities arise from bimetallic junctions in service probably due to the varying passivity of these metals under changing conditions. It is difficult to determine the contact potential of these metals in practice and to obtain a "steady value." Table 5 gives some figures for the steels. The cast irons and plain carbon steels are quoted as − 0·70 which again is rather a difficult figure to establish due to varying passivity in the initial stages of the test. The 12 per cent chromium alloy is given as − 0·45, the 18 per cent one as 0·35, and the 18 per cent chrominum 8 per per cent nickel alloy as − 0·20. The influence of the high nickel content in rendering the latter more noble should be noted. This particular alloy is thus closely similar to copper and the copper/rich alloys for contact potential, but appreciably removed from the aluminium and aluminium alloys rendering performance doubtful if used in contact with the latter.

Fig. 3 shows stainless steel strips, fixed with aluminium rivets to aluminium, after three days' salt spray test. The attack on the aluminium is more severe than if there were no contact with stainless steel and its is particularly concentrated around the rivets and along the junction between the dissimilar metals. There is little to choose between the two samples, if anything the 12 per cent chromium steel A being a little superior to the 18 per cent chromium eight per cent nickel alloy B.

The diaphragm assembly of the telephone transmitter is one illustration of the possible devastating effect of high

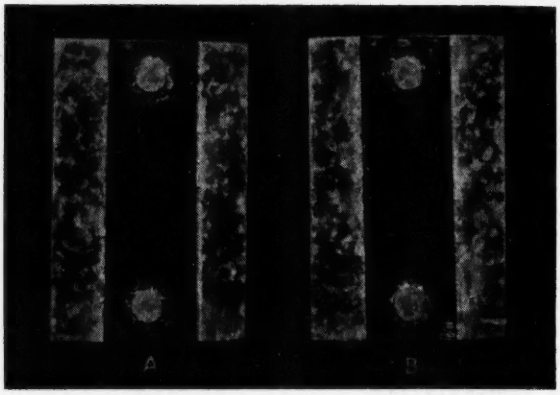
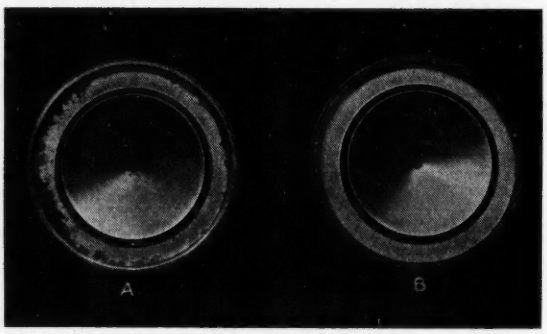


Fig. 3 (above). Stainless steel in contact with aluminium after salt spray test

Fig. 4 (below). Bi-metallic junctions between aluminium diaphragm and metal case after salt spray test. A. Nickelled brass case. B. Chromated zinc case



contact potential. Fig. 4 shows the effect of salt spray conditions. A is the aluminium seven per cent magnesium alloy diaphragm against nickel plated brass clamping ring and case. It shows the heavy corrosion of the diaphragm from the bimetallic junction, this occuring in five days. B is the same kind of diaphragm assembled against chromate passivated zinc, showing very little deterioration after ten days of the test. These artificial results coincide with experience from practice under severe service conditions.

Unlimited test results could be quoted and many experiences from practice. From the design angle, the sound procedure is to avoid excessive potential differences. Metal finishes provide the practical aid in this direction, but the quality of the finish in all respects must be assured. From the manufacturing angle, process control must be established to ensure the latter.

Pulse Duration Modulator Circuit

By F. Butler, B.Sc., M.I.E.E., M.Brit.I.R.E.

A circuit for the production of duration modulated pulses is described, employing a hard valve generated developed by D. A. Levell.

The pulse duration and repetition rate may be varied over wide ranges. The circuit includes a trigger pulse generator and shaping circuit, the complete equipment being designed for single channel voice frequency communication purposes.

IN 1952 a description was given by D. A. Levell[1] of a new type of hard valve pulse generator. The present note shows how the original circuit may be adapted to produce duration-modulated pulses suitable for single channel voice communication purposes. The requisite modifications are simple and straightforward and the

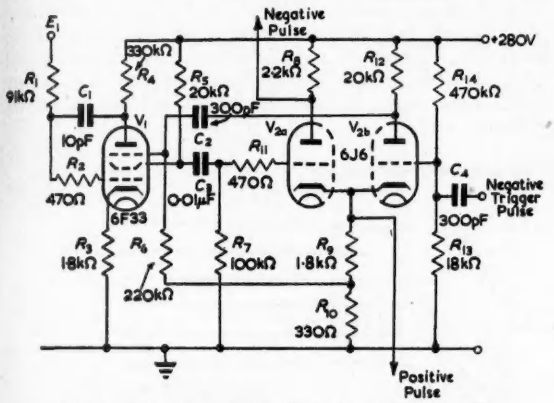


Fig. 1. Basic pulse generator circuit due to D. A. Levell

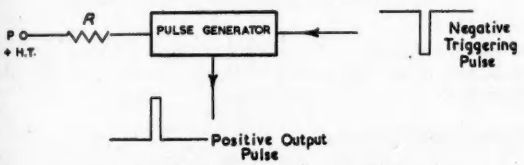


Fig. 2. Block diagram of the pulse generator

performance of the pulse generator is not impaired by the provision of facilities for modulation.

The circuit, as already described, is shown in Fig. 1.

Reference to the original article will make clear the mode of operation of the generator, which for the present will be regarded simply as a box which produces positive pulses at its output terminals in response to a recurrent negative triggering pulse, the time duration of each output pulse being dependent on the direct voltage E_1 applied to the free terminal of a high-value resistor connected to the pulse generator. The arrangement is shown schematically in Fig. 2. The resistor R is of the order of 100kΩ and on varying the potential of the point P between 15 and 280V the pulse duration changes smoothly from 12·8 to 0·7μsec.

Fig. 3 shows the relationship between the pulse duration and the potential of P. The characteristic curve is a rect-

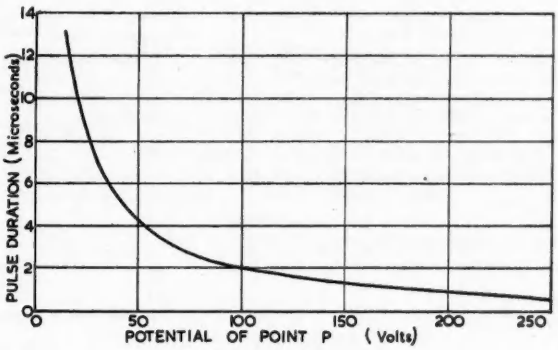


Fig. 3. Pulse duration characteristics

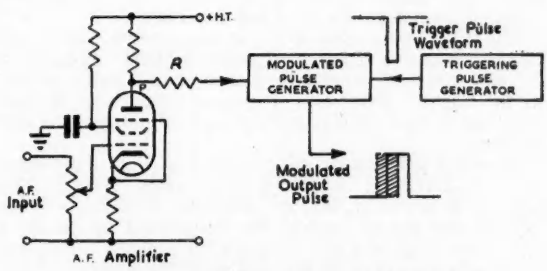


Fig. 4. Schematic diagram of pulse modulator circuit

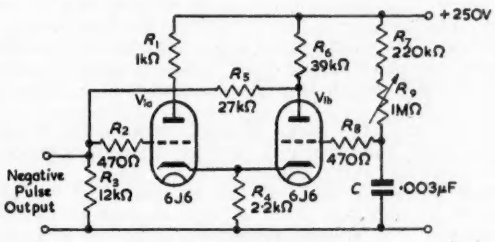


Fig. 5. Trigger pulse generator

angular hyperbola for which the average value of the product of voltage and pulse duration is numerically equal to 206.

Audio-frequency modulation of the pulse duration can be achieved by connecting the point P to the anode of a suitable amplifier valve. The simplest possible arrangement is shown schematically in Fig. 4. The complete pulse

modulator requires only the addition of a triggering pulse generator of conventional design. For this part of the equipment a twin triode valve is used in a cathode-coupled multivibrator circuit in preference to the possible alternative of a self-running transitron. Fig. 5 shows the circuit arrangement finally chosen.

Practical Pulse Modulator Circuit

A complete circuit diagram of the equipment is given in Fig. 6. It consists of the original pulse generator, an audio frequency amplifier and a trigger pulse generator, together with a few additional circuit components designed to

One valuable feature of the system is that overmodulation of the pulse is virtually impossible. In cases where low distortion is of importance, a simple palliative may be applied without further complication of the circuit. The principle is to make use of deliberate distortion in the pentode audio frequency amplifier by choosing a load resistance and by setting the electrode voltages so that a non-linear modulating voltage is applied to the pulse generator. The principle of the method is illustrated in Fig. 7. This shows a family of pentode characteristics with an operating point and a load line so chosen as to produce distortion of the opposite sense to that which is introduced

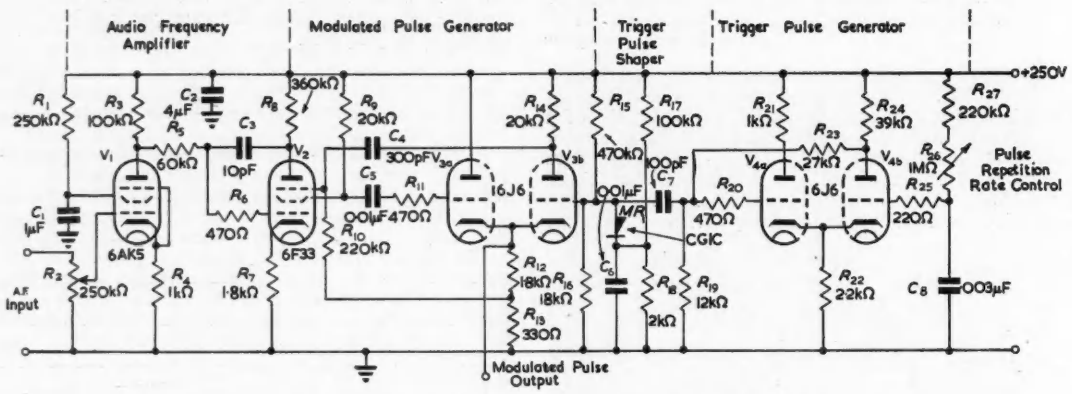


Fig. 6. Complete circuit diagram of the modulated pulse generator

improve the triggering characteristics. A few minor changes have been made in the primary pulse generator circuit. One is the omission of a valve anode load resistor, since negative output pulses were not reguired.

The trigger pulse generator is required to produce a train of short negative pulses having an amplitude in excess of 5V and with a recurrence frequency at least twice as great as the highest modulation frequency which is to be used. This is a fundamental requirement of all pulse modulation systems.

With the component values shown in Fig. 6 the recurrence frequency is variable over the range 9-14kc/s. The control is normally set for operation at 12kc/s, which permits the use of modulation frequencies up to 6kc/s. This is adequate for any normal communication purposes. The output pulse is rather too wide for good triggering and after differentiation by the short CR circuit consisting of C_7 and R_{16} two narrow pulses of opposite polarity are produced. The positive pulse is undesirable, since it causes a spurious response in the output from the modulated pulse generator. Its effects are entirely removed by the diode clipper circuit consisting of R_{17}, R_{18}, C_6, and the crystal rectifier MR_1 which is a B.T.H. germanium diode type CG1C.

Except for a few minor circuit changes, some of which have already been specified, the modulated pulse generator is as described in the article by D. A. Levell.

The remaining part of the equipment is an audio frequency amplifier which is D.C. coupled to the pulse generator. The greatest permissible depth of modulation calls for negligible power from this amplifier.

Inspection of Fig. 3 reveals that the modulation characteristic is decidedly non-linear except along the asymptotes of the hyperbola, which correspond to very long or to extremely short pulse durations. It might be expected that deep modulation would be accompanied by strong second harmonic distortion, but experience shows that with voice signals fed at high level into the modulator there is little obvious degradation of quality.

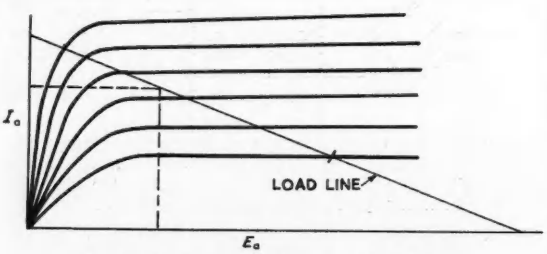


Fig. 7. Production of non-linear modulation voltage

in the modulation process. Subterfuges of this type are inadmissible in high fidelity working, but are entirely satisfactory in communication practice.

Experimental Results

The equipment was set up to produce pulses of 5μsec duration at a recurrence frequency of 12kc/s. The pulse amplitude was 80V peak and the rise and decay times were each about 0·5μsec. Application of a D.C. signal to the amplifier valve varied the pulse duration over the expected range. Similar checks were made at other pulse widths between the limits of 1 and 10μsec. They were repeated for recurrence frequencies between 3 and 15kc/s, the lower frequencies calling for a change of capacitor in the trigger pulse generator, no change being required in the main pulse unit.

To extract the audio frequency from a duration-modulated pulse train it is sufficient to apply the pulses to a low-pass filter. An integrator circuit can also be used to increase the output signal level, but the efficiency varies with the modulating frequency. Distortion is caused and equalization becomes necessary. For experimental purposes, the unit shown in Fig. 8 was constructed. It consists of a cathode-follower feeding a low-pass filter, the output of

which is amplified to a level high enough to operate a loudspeaker. The tuned circuit in the cathode lead of V_2 is set to reject the pulse repetition frequency.

With the output of this unit connected to an oscilloscope and with a range of audio frequency tones applied to the pulse modulator, examination of the waveform showed little trace of distortion over the whole frequency range. Lack of suitable equipment precluded an attempt at distortion measurement, but a check with a broadcast programme fed into the pulse modulator showed little difference between the quality of reproduction when the loudspeaker was changed over from the radio receiver to the output of the pulse detector. Some low-level heterodyne interference was caused by radio-frequency harmonics of the pulse output from the generator. Physical separation of the pulse generator and the receiving aerial eliminated this effect.

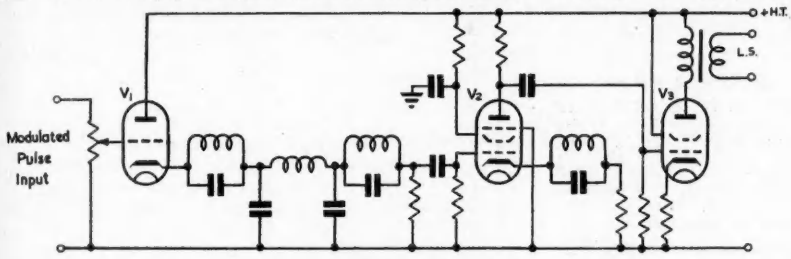


Fig. 8. Pulse demodulation circuit

Conclusion

The unit described produces a train of modulated pulses of whch all the parameters can be varied over an extremely wide range. Its components are non-critical in value and the pulse shape is extremely good. The current consumption is 30mA at 250V and the performance is scarcely affected by normal changes in supply voltage. A high-level output pulse is available from a low-impedance source. In its simplest form the non-linearity of the pulse modulator characteristic might be objectionable, but correction of this fault is not unduly difficult and it can be achieved without additional circuit complication.

The pulse modulator is only suitable for single-channel working and there is no simple way of providing for multiplex operation.

Acknowledgment

The writer is indebted to J. D. Storer for designing the trigger pulse generator and for conducting initial tests on the finished equipment.

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1. LEVELL, D. A. A Hard Valve Pulse Generator. *Electronic Engng. 24*, 507 1952). (see also Erratum (ibid) p. 587.

A Simple Analogue Divider

By J. L. Douce*, M.Sc.

A simple circuit is described with an output voltage proportional to the ratio of two input voltages. The device is accurate to 5 per cent over a wide range of inputs.

MANY occasions arise where it is desirable to compare the amplitude of two voltages, with a fair degree of accuracy. One particular application is in the construction of an automatic Nyquist diagram plotter for a feedback system, where the open loop gain is most easily found by comparing two variable signals, the output amplitude and the error signal. The usual method of performing this operation is to use an electromechanical servo system[1]. This can give results of high accuracy, but suffers from two disadvantages. In many cases the cost and complexity of such equipment may not be justified, and the maximum frequency of operation is limited to about 10c/s.

The electronic method to be described uses standard components only, including three pentodes and three diodes. The device is effective for positive input signals only, and for input frequencies from zero to a pre-determined maximum.

Principle of Operation

Let the two input voltages be v_a and v_b such that the desired output is given by

$$v_{out} \propto v_a/v_b \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

The above relationship is fulfilled by deriving a pulse of duration inversely proportional to v_b and using this pulse to gate the input v_a, so that an output pulse is obtained of amplitude v_a and of duration proportional to $1/v_b$. This process is made repetitive, the repetition rate being much higher than the maximum input frequency. The final output is obtained by smoothing the pulses obtained, using a simple *RC* filter. The time-constant of this filter is made large compared with the repetition period.

The variable width pulse is obtained by using the basic

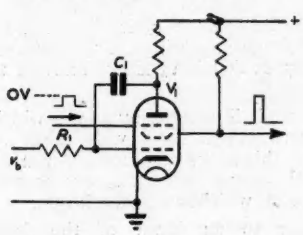

Fig. 1. Basic circuit of the pulse generator

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circuit of Fig. 1 which is a suppressor switched Miller integrator[2]. The rate of run down is given by

$$-dv_1/dt = v_b/C_1R_1 \quad \ldots\ldots\ldots\ldots \quad (2)$$

It follows that the run down time, and hence the time during which the screen current is small, is inversely proportional to the voltage v_b. The complete circuit of the divider used is shown in Fig. 2.

The Practical Circuit

Referring to Fig. 2, the input network R_2R_3 provides apropriate bias for V_1 so that with the input earthed the anode potential falls very slowly. The voltage level of the pulse appearing on the screen grid of V_1 is changed by R_4R_5 so that the lower level of the waveform at the junction of R_4 and R_5 is several volts negative. While the

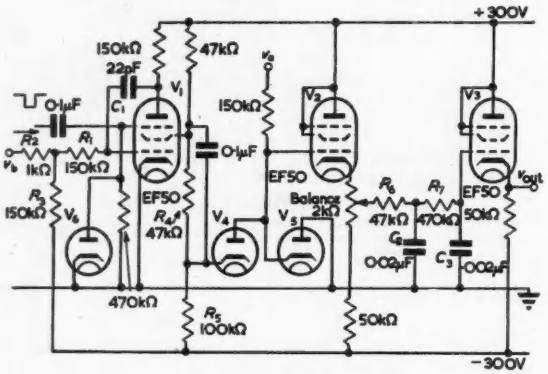

Fig. 2. The divider circuit

anode of V_1 is falling, the screen current is small, hence the cathode of V_4 is positive, and both V_4 and V_5 are non-conducting. Thus v_a is applied to the smoothing circuit R_6C_2, etc. When the screen grid potential of V_1 is low, that is when either the anode is bottomed or anode current is cut off by the suppressor voltage V_4 and V_5 conduct, so that v_a now has no effect on the outut voltage, which tends to zero. It follows that the output voltage is proportional to v_a/v_b, as required.

Permissible Range of Inputs

The permissible range of v_b is limited by two factors.

(a) v_b must be sufficiently large to ensure that V_1 bottoms before anode current is cut off by the suppressor, and must be of several volts amplitude to give a linear run down of anode voltage.

(b) v_b must not be so large that the duration of the pulse appearing on the screen grid is comparable with the rise and fall time of this pulse.

A suitable range for v_b is found to be from 5 to 100 volts.

The only limitation on the voltage v_a is that it must not exceed the positive voltage appearing on the cathode of V_4. A safe margin is provided if v_a is not allowed to exceed 60 volts.

The behaviour of the unit is illustrated by Fig. 3 which gives the input-output relationships for a wide range of D.C. input voltages. From this series of graphs, it can be shown that the error of the output voltage is not greater than ± 5 per cent ± 0·1 volt, whichever is the larger.

The frequency response to an input of the form

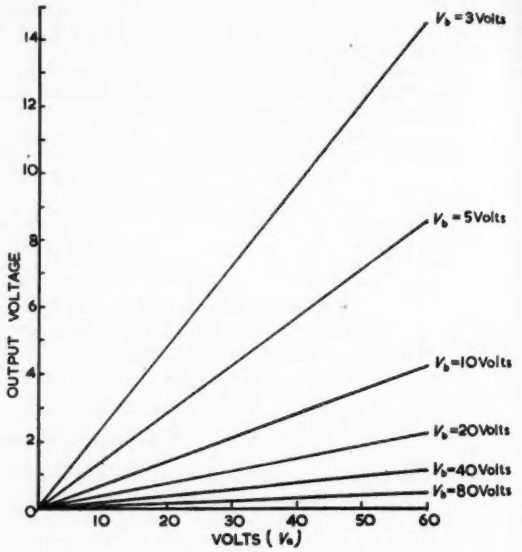

Fig. 3. Experimental response of the unit

$v\,(1 + m \sin \omega t)$ for $|m| < 1$ is shown in Fig. 4, with either v_a or v_b varying with time. In each case the response is 3db down at about 100c/s. This is due to the gating of the waveforms, which takes place at 1 000c/s and the unit could be modified to handle higher input frequencies by increasing the switching frequency.

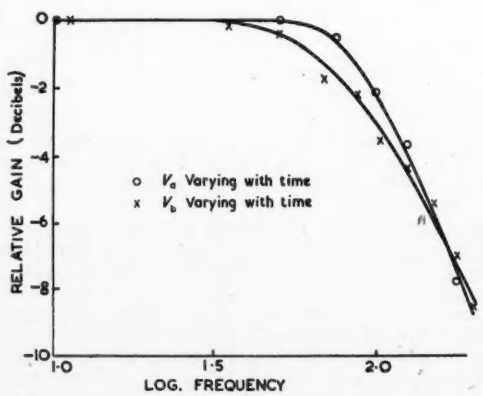

Fig. 4. Frequency response of the unit

Conclusion

A simple circuit has been presented which gives the ratio of two voltages with an accuracy sufficient for many practical purposes. Standard components are employed, and the method has considerable advantages over the servo-mechanism type of divider. The unit has proved reliable in operation and retains its calibration over a long period of time.

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2. Briggs, B. H. The Miller Integrator. *Electronic Engng. 20,* 243 (1948).

An Industrial Batching Counter

By R. W. Brierley*

A counting equipment is described which controls the batching of mass-produced articles into small pre-determined quantities. The design is based upon a cold-cathode trigger tube, the Hivac XCII, and illustrates the simple "carry-forward" and reset circuits which may be used with tubes of this type.

The individual circuits are discussed in detail.

ONE of the many industrial uses of electronic methods of counting is the batching of mass-produced articles into small quantities either for further processing or for final packing. Electronic counters, using thermionic valves and based upon the various well-known scale-of-two-circuits, have already been used for this purpose but their capabilities, particularly in relation to counting speed, have been usually far in excess of the actual requirements. The newly developed cold-cathode tubes, however, have now made possible the design of an equipment which is considerably less complex than its thermionic counterpart yet whose maximum counting rate is still adequate for the majority of applications. It is the purpose of this article to describe such an equipment.

Cold-cathode tubes, in general, are admirably suited for industrial counting equipment; in addition to the obvious advantage of not requiring a heater supply, they are self-indicating and, by virtue of their two stable states, readily formed into counting rings with but few additional components. The single triode type is particularly advantageous in that it can be used to form not only counting rings of any desired scale but also a wide variety of pulse-forming circuits. Thus, in the batching counter to be described, all tubes, with the exception of a VR150 stabilizer and a 6J5GT triode, are of one standard type.

General Description

The exterior and interior appearances of a complete counter are as shown in Fig. 1 and 2. Looking from right to left in Fig. 2, the four vertical panels contain respectively (a) the power supply, together with the input, batching and reset circuits, (b) the units counter, (c) the tens counter and (d) the hundreds counter. The units and tens panels are both equipped with the full complement of 12 tubes and, reading upwards, these are (a) the start tube, which fires automatically each time the unit is switched on or reset, (b) a decade counter and, (c) the carry-forward tube. This latter tube fires momentarily at each tenth pulse and drives on the succeeding counter by one step.

The unit illustrated is intended to count up to 199, to cover batches of a gross, and the hundreds panel, in consequence, has only two counting stages. Substitution of a standard, fully-equipped panel increases this total to 999 and when a still further increase is required, additional decades can be added without any circuit modification.

Each panel, in addition to the tubes already referred to, has a rotary selector switch with which the batch quantity can be set; if, for instance, a batch of 175 is required, the hundreds switch is set to 1, the tens switch to 7 and the units switch to 5. When this quantity has been counted, the upper relay on the power supply panel operates and its contacts are used, via suitable ancillary gear, either to stop a feed mechanism, swing a gate across a conveyor or otherwise control the machine as required. Resetting, after the clearance of a completed batch, is accomplished either by a built-in push-button or, more

* *Formerly Teledictor Ltd.*

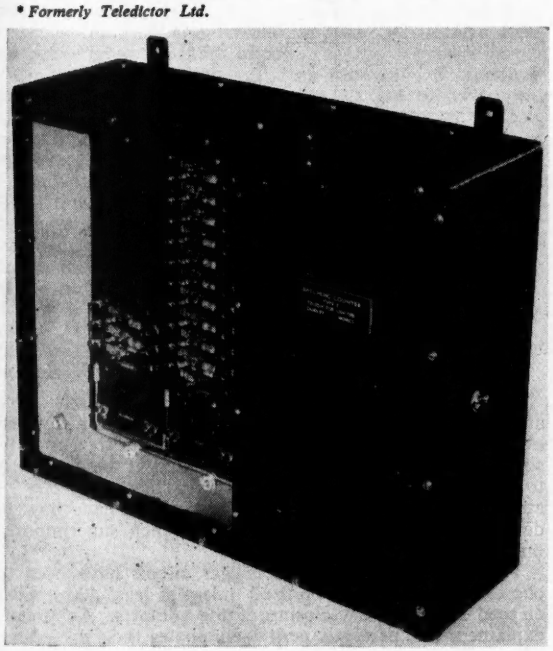
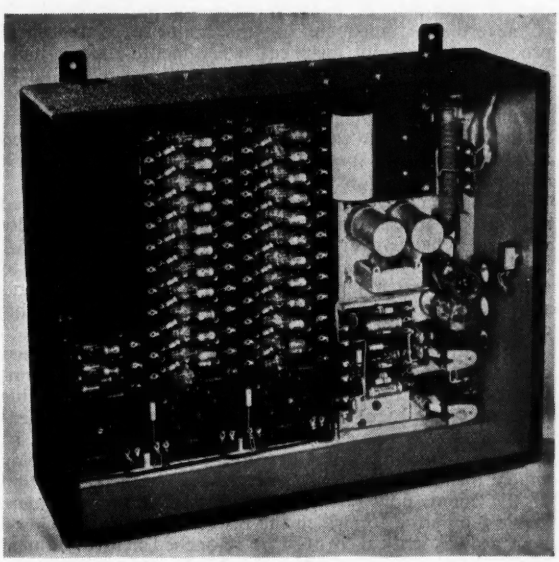


Fig. 1 (left). Exterior view of batching counter

Fig. 2 (below). View of counter with front cover removed



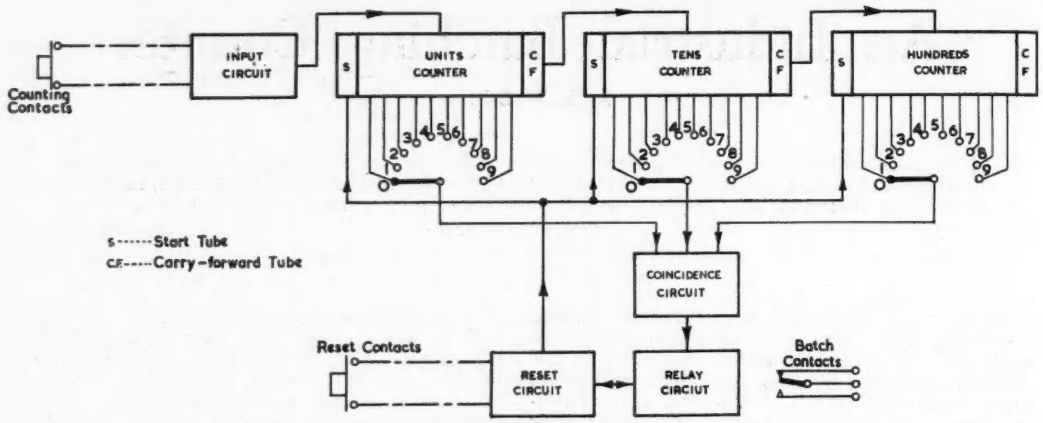


Fig. 3. Schematic Circuit of Batching Counter

usually, by a remote contact operated by the machine.

The three selector switches, mentioned earlier, are mounted within the unit and are adjustable from outside by a screwdriver inserted through bushes in the Perspex panel. When these bushes are sealed off, after setting the required batch quantity, the entire unit is completely dustproof.

Operational Details

In order that the equipment should, as far as possible, be a standard unit and, as such, readily applicable to a wide range of both plant and product, it was designed to operate from the closing of a pair of contacts or, alternatively, from a positive voltage pulse of not less than 50 volts amplitude. Dependent upon the product to be counted, the contacts referred to may be either a simple buffered spring-set operated directly by the passage of the articles, a microswitch similarly used or, the relay contacts of, say, a photo-electric unit or other standard detecting device. False counting, which would result from the presence of contact bounce, is eliminated by fixing the resolution time of the input pulse-forming circuit at 40msec, equivalent to a maximum operating speed of 25 counts per second. While this speed is low in comparison with that of counters using thermionic valves, it is, nevertheless, adequate for the majority of industrial processes. In many instances, when photo-electric pick-ups are used, it is usual to dispense with the relay and to feed the batching counter with pulses derived directly from the photo-cell amplifier. Relay life is not then a limiting factor and the whole equipment, of course, can be operated at a much higher speed than would be possible with a standard type of relay.

The batching relay, which operates when the required number of articles has been counted, is fitted normally with one change-over contact, capable of switching 5A at 250V A.C., and, as previously explained, is used to control the batching mechanism. Both solenoids and solenoid-actuated air-valves are commonly used in this connexion.

In arranging for automatic reset after a batch has been counted, provision is made for a light-duty contact, conveniently, a micro-switch, to be operated by some suitable motion of the machine. This contact energizes momentarily the lower relay on the power supply chassis and so resets all counting tubes to zero. The batching relay which, meanwhile has been energized since the completion of the count, now releases and initiates a further batch. While the period for which the reset contact is held closed is in no way critical, it must be re-opened before the next batch is complete. In addition, the reset circuit is so arranged that it cannot operate until the set quantity has been counted; the final total, therefore, is protected against any accidental operation of the reset contact.

Cold-cathode tubes of the coated-cathode type, such as used in this equipment, should not be operated in complete darkness. Without any incident light, their characteristics become very variable and, for this reason, and to make the equipment independent of external lighting conditions, the counting tubes are illuminated by a small 15 watt lamp mounted within the unit.

Details of the Circuits

A schematic diagram of the complete circuit is shown in Fig. 3.

INPUT CIRCUIT

The circuit shown in Fig. 4 is of the self-extinguishing type and provides the driving pulses for the units counter.

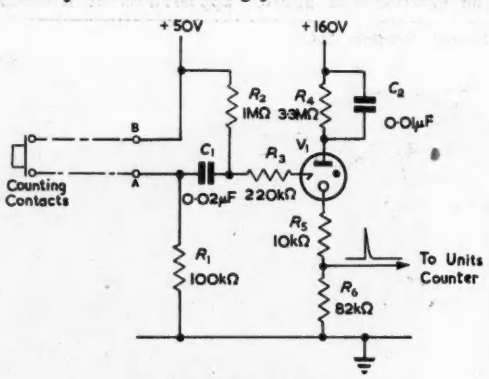


Fig. 4 Input circuit

To strike V_1, a positive pulse of approximately 100V amplitude is required at the trigger. This could have been obtained by returning the counting contacts to a +100V source, but, in order to keep the potential at these contacts to the lowest practical value, a fixed bias of +50V is applied to the trigger via R_2. The contacts have now to develop only a +50V pulse which is then superimposed on the bias.

The time-constants of the trigger circuit have been so chosen that V_1 cannot be fired unless at least 40msec has elapsed since the last closing of the contacts. As already explained, this paralysis period eliminates the false count-

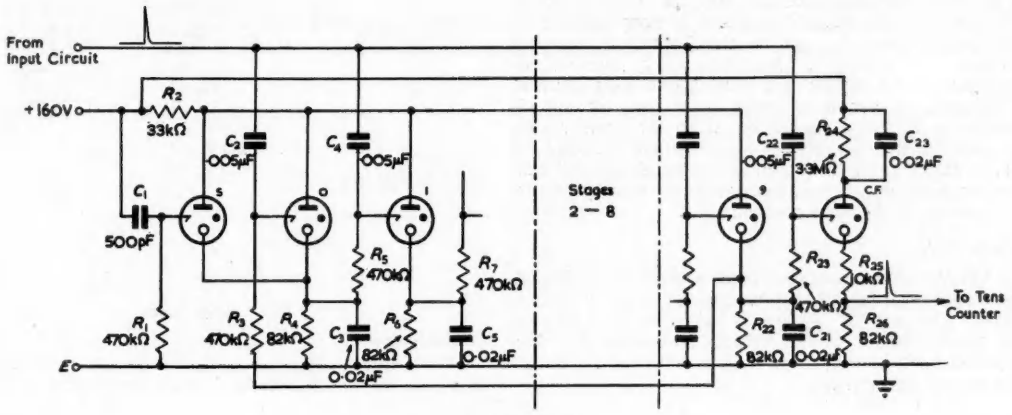


Fig. 5. Counting circuit

ing that would result from bouncing of the contacts after the initial closure. It is effective for a wide variety of contact arrangements.

At each firing of V_1, the main gap discharges C_2 into the cathode resistor, consisting of R_5 and R_6. R_4, in the anode circuit, is of adequately high value to ensure that, once C_2 is discharged, there is insufficient current available to the main gap to maintain ionization; the tube therefore extinguishes. As a result of this action, there is produced across the cathode resistor a positive pulse of approximately 85V amplitude at each closing of the contacts or, alternatively, for each application of a +50V pulse at the point A. Only +60V pulses are required for the counting circuits and the output is taken, therefore, from the junction of R_5 and R_6.

Counting Circuits

The equipment illustrated has three counting circuits conected in cascade to record units, tens, and hundreds. All three are identical in operation and only one need be described here in detail. Fig. 5, therefore, will be taken to represent the units counter and, as such, will receive driving pulses from the input circuit.

On the application of H.T., the start tube S is struck automatically by the +160V pulse applied to its trigger by C_1. With a nominal anode-cathode tube drop of 75V, approximately 60V is developed now across R_4, which is common to both tubes S and O, and this potential is fed via R_5 as a bias to the trigger of tube 1. Being so primed, tube 1 thus strikes on receipt of the first +60V pulse from the input circuit and, because of the presence of the cathode capacitor C_5, reduces the common anode potential, at the instant of firing to approximately + 75 volts. At the same instant, C_3 is holding the cathode of tube S at +60V and with now only 15V across anode and cathode, tube S is forced to de-ionize. One input pulse, therefore, has fired the primed tube and extinguished the preceding one.

This process continues progressively throughout the circuit with tube 9 being so connected as to prime tube 0 and, in addition, the carry-forward tube, *CF*. This latter tube, as reference to Fig. 5 will show, is employed in a self-extinguishing circuit which, at each tenth input pulse fires momentarily and drives on the tens counter by one step. The carry-forward tube of the tens counter operates in exactly the same manner and, at each hundredth input pulse, the hundreds counter is driven forward.

Coincidence and Relay Circuits

To signal the completion of any particular batch quantity, it is now necessary to detect the coincidence of three separate +60V potentials; i.e. the cathode potentials of one particular tube from each of the three counting circuits. As will be seen in Fig. 6, a three-rectifier coincidence circuit is employed and it will be apparent that until all three rectifier cathodes are lifted to +50V or above, V_{3B} grid is held virtually at earth potential. Since its cathode is at +25V, V_{3B} is thus completely cut off and relay A, in its anode, is unenergized. When, however, the particular counting tubes to which the rectifiers have been switched by S_1, S_2, and S_3 are all burning simultaneously, i.e. when the required quantity is reached, then all three rectifiers block and V_{3B} grid is allowed to rise to +50V. V_{3B} now conducts and energizes the batching relay A.

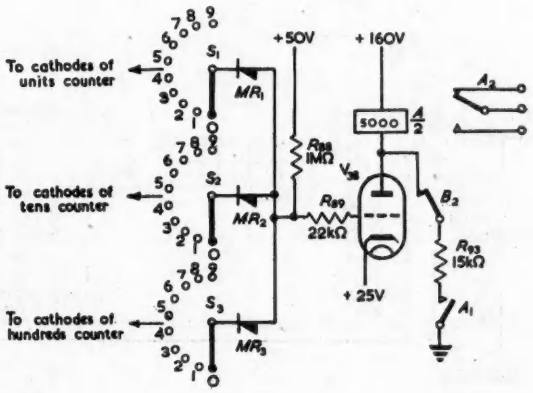
No attempt is made to render the counters inoperative when relay A is energized since, if this were done, there would be no check on whether or not the machine had actually cut off at the required quantity. Overrun can quite easily occur in the first designs of fast-feeding mechanisms, but by arranging for relay A to hold-on via contact B_2, R_{93} and its own contact A_1, any such overrun is immediately apparent as a difference between the pre-set and the recorded quantities. Without the hold-on circuit, of course, relay A would release on the overrun and allow feeding to continue.

Reset Circuit

Resetting, either by the built-in push-button or a remote "make" contact, is effected by removing and then re-applying the H.T. to the counting circuits. Whichever tubes are burning are thus extinguished and as H.T. is restored, the three start tubes strike automatically.

Referring to Fig. 7, it will be remembered that when the

Fig. 6. Coincidence and relay circuits



batch quantity has been counted, relay A is energized by V_{3B}. On closing the reset contact, it is now possible to energize relay B, via R_{93}, and its own contact B_1 removes H.T. from the counters. Simultaneously, contact B_2 releases relay A, A_1 opens and thus de-energizes relay B. This sequence of events is quite rapid and the H.T. is interrupted only for a period equal to the sum of the release times of the two relays. Since neither V_{3B} conducts nor A_1 is closed until the batch is complete, relay B cannot be energized and hence, the unit reset, by any premature operation of the reset contact.

Power Supply

This follows conventional lines and consists of a selenium bridge rectifier followed by smoothing and a VR150 stabilizer. The H.T. of +160V is taken from a tapping on the anode resistor of the VR150, and while this does not give complete stabilization, it is, nevertheless, adequate for the present equipment.

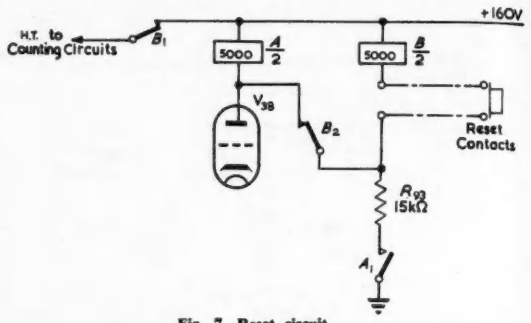


Fig. 7. Reset circuit

Acknowledgments

The author wishes to thank the Directors of Teledictor Limited for permission to publish this article.

A Cold Cathode Batching Counter

By P. E. Tooke*

FOR industrial use, a counter for batching steel components in pre-selected batches, was required to operate at a speed of up to 200 per second. The transfer mechanism used to separate the batches had already been proved satisfactory, but due to the necessity of having to weigh the components against a standard batch, it was decided to develop a faster method of batching.

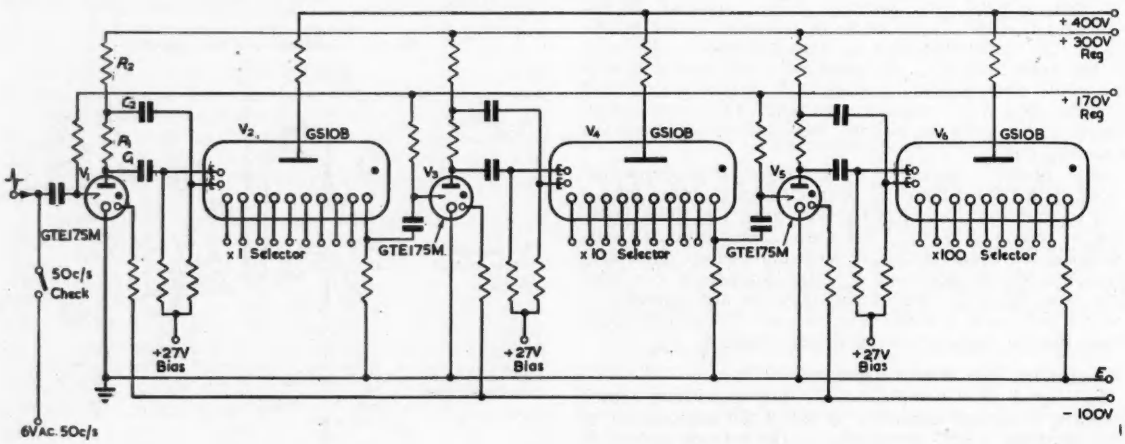
The initiation of the transfer mechanism was simple, a solenoid operating a small clutch was pulled over for a time period of not less than 0·1 sec. During this time however, the counter was required to reset itself and continue counting, as the components were fed at the same rate during the actual separation of the batches, merely being finally fed into different trays.

A design using double triode counters, and several relays was discarded owing to the complexity of the circuit, and its unreliable operation under industrial conditions. A metallic dust laden atmosphere, together with vibration, were two factors that had to be considered. It was necessary for the equipment to be sealed, but in so doing the problem of heat dissipation had to be overcome. It was decided that cold-cathode valves with their rigid electrode structure, and low heat radiation would be advantageous and were, therefore used throughout. The final equipment will run for eight hours continuously, with only a 10° C. rise in temperature.

Three GS10B Dekatron tubes were used, coupled with GTE175M trigger tubes. As these tubes have a maximum counting rate of 550 per second this easily covered the requirement. A 1 267 cold-cathode thyratron was used as the final valve with a relay in the cathode to switch mains for the outpulse. Metal rectifiers, and paper capacitors were used throughout. Selection of the batch number was by means of three front panel switches, each 1-9, with one blank position. These switches were arranged to select units, tens and hundreds, so that a direct reading could be obtained of the number selected. A reset button for manual zeroing, and a mains button for feeding 50c/s

* *The Electronic Machine Co., Thornton Heath.*

Fig. 1. The counter circuit



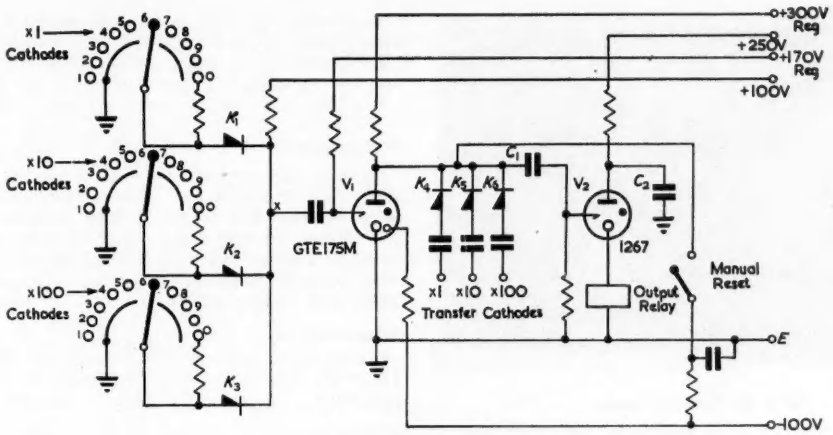


Fig. 2. Selector and reset circuit

into the counter for checking purposes, were all the controls that were thought necessary. The whole unit was contained in a gasket sealed steel case.

The Counter Circuit

Fig 1. shows the counter circuit. The input pulse is fed via a 0·001μF capacitor to the trigger of a GTE175M (V_1). The 170 volt bias on this tube ensures that it will trigger with a positive going pulse in excess of 5 volts, and a duration of not less than 100μsec. The anode of this tube is coupled to the first guides of the Dekatron selector (V_2) through a small capacitor (C_1). The second guides are fed from a tapping on the anode load (R_1 R_2) via a larger capacitor (C_2). When V_1 triggers, both capacitors discharge, and due to the tapped anode load, the negative pulse passed to guide one, is larger in amplitude than that to guide two. Therefore, the glow transfers from V_2 cathode to guide one. On discharge of the capacitors C_1 and C_2, V_1 resets, due to the insufficient current passed by the anode load, which unless supplemented by the discharge of the capacitors, will not maintain the burning voltage. The charging of C_1 and C_2 causes guide 1 of V_2 to become more positive than guide 2, owing to the difference in the time-constants; thereby causing the glow to invest guide 2 until that becomes sufficiently positive with respect to the cathodes, when the glow transfers, completing one count. This occurs until the output pulse from V_2 triggers V_3, which then drives V_4, and so on. Should any cathode of the GS10B's be made negative to all the others, the glow will jump to this cathode. This will then reset the counter to zero if a negative voltage is applied to all the transfer cathodes.

The Selector and Reset Circuit

Fig. 2. shows the coincident gate and reset circuit. The three sliders of the selector switches having been switched to the appropriate cathodes, are each connected to blocking rectifiers MR_{1-3}. A bias is applied to the positive side of these rectifiers, which are also connected to the trigger of the gating tube. Under normal working, the rectifiers pass current via the Dekatron loads R_1, R_2, R_3 However, when the glow rests on a cathode which has been selected, the Dekatron current passing through that cathode load, causes a voltage drop across it which is sufficient to block the rectifier. As there are two other rectifiers passing current, the voltage at point x does not rise until all the selected cathodes have a glow resting on them, then the positive rise at x fires the trigger tube V_1. To give counts of less than 100 or 10, the cathode loads R_1, R_2, R_3 are returned to the blank pin on the selector switch, which in all other positions is earthed by the earthing slider, but open circuits its own rectifier, so allowing only two or one rectifier block before V_1 is triggered.

On V_1 triggering, the negative going pulse at the anode is fed via three rectifiers MR_{4-6} to the 10th cathode of each Dekatron. The negative pulse developed across the load is sufficient to reset these if the anode resistor of V_1 is of the order of 1·5MΩ. MR_4, MR_5 and MR_6 prevent the pulse from the Dekatrons from firing V_1 when the glow is passing the transfer cathode.

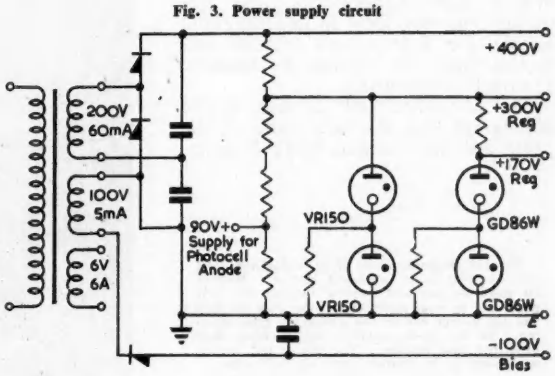
Another way of reseting when the counting rate is not so high and therefore the reset time can be shorter, is to apply a separate negative 100 volts to the cathodes of the Dekatrons through a pair of contacts on the output relay. This also has the advantage that when the manual reset is operated it does not fire the output 1267, and so actuate any mechanisms worked by the relay.

V_2 is fired by the pulse from V_1, the coupling capacitor C_1 on discharge resetting V_1 ready for the next batch pulse. A large capacitance (C_2) across V_2 ensures the relay being held on long enough to work a small solenoid. The voltage at the anode of V_2 is also arranged so that on discharge of C_2 the anode voltage has fallen below the burning voltage, thereby resetting for the next pulse.

Power Supplies

The power supplies proved to be very simple and straightforward, hardly any smoothing being required. Two VR150's were used to stabilize the anode supply for the trigger tubes. From the 300 volt regulated supply, two GD86W'S further regulated a 170 volt line for the trigger bias. A 100 volt negative supply for the trigger bias and

Fig. 3. Power supply circuit



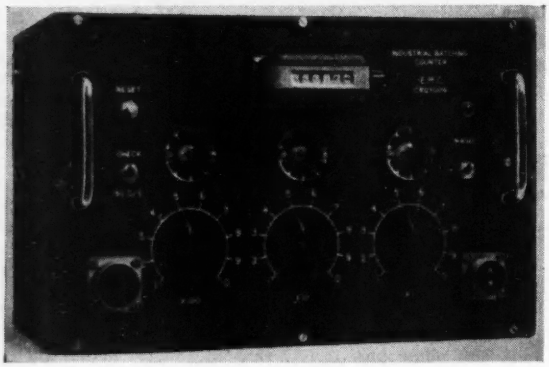


Fig. 4. The batching counter

manual reset was from a separate winding on the transformer, which also had a 6 volt 6 amp winding for the photocell exciter lamp. A bleeder chain across the unregulated 400 volt line supplied the anodes of the 1 267 tubes and photocell. Fig. 3 shows the basic circuit of the power pack.

Performance

In use this counter showed complete reliability, and accuracy of counting. A photocell amplifier, giving a short output pulse, was found to give freedom from jumping and missing counts. The counter input circuit is insensitive to hum pick-up, therefore, a long input lead can be tolerated without elaborate screening. The complete instrument is shown in Fig. 4.

Acknowledgments

Thanks are due to The Electronic Machine Co., of Thornton Heath, for their permission for this article to be published.

LEO

Lyons Electronic Office

An automatic digital calculator has been designed, built and installed for their own use by J. Lyons & Company, Ltd., at Cadby Hall, W.14. It was designed specifically for commercial clerical work and is believed to be the first of its kind in regular use for this purpose. A section of the payroll and cost accounting and stores control jobs are being done regularly each week, and several other jobs are in the preparatory stages. A considerable amount of scientific calculation has also been done over the past two years on contract for Government departments and other bodies.

The original proposal to use an electronic calculator in the office was made in 1947 by a member of Lyons own staff, and in 1949 it was decided to build one based on the Cambridge EDSAC[1]. Dr. M. V. Wilkes, the designer of the EDSAC, made available details of its design. As compared with that machine the principal differences are an increase in the capacity of the store to hold 2048 numbers or orders, and the provision of multiple high speed input and output channels for data and results. Two other minor improvements have previously been described in these pages[2]. Between September 1949 and Christmas 1953 when the installation was finally completed, about 18 months was spent on designing, testing and installing on site the units which were manufactured by Wayne Kerr Laboratories. The rest of the time was spent in designing and testing the input-output circuits and finding ways for making the machine thoroughly dependable.

The calculator itself is seen in the photograph; on the other side of the room are two Ferranti Mark I photoelectric readers for punched tape, and a Hollerith card reader used for data inputs. Output is recorded by a Hollerith type printer and card punch. All wiring to these mechanical units is concealed in under floor ducting. The arrangement of the circuits linking the mechanical units to the calculator cannot be fully described here, but it enables the various data and result channels to operate independently up to their maximum rate if necessary. In this way the machine can deal efficiently with office work, in which the volume of data and results is always large in relation to the arithmetical calculations required, in contrast to scientific work in which the number of data and result figures is much smaller. In fact, the machine can tackle any clerical work which can be reduced to a series of precisely determined arithmetical operations, with provision for wide variations in the procedure to suit the circumstances of particular cases.

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   Lenaerts, E. H. Visual Presentation of Binary Numbers. *Electronic Engng.* **23**, 140 (1951).

The 220 electronic units of the calculator itself are mounted in 21 enclosed racks. Built-in air ducts at top and bottom remove the heat generated by over 5,000 valves; the cold air duct and the power wiring run under the false flooring. In the background is the monitor desk used for fault-finding. The input and output machinery is in another part of the room.

Slotted Line Impedance Measurements

By E. G. Hamer*, B.Sc.

THE use of slotted lines either of the coaxial or slab types to measure unknown impedances at V.H.F. and U.H.F. is a well-known technique. A measurement of the standing wave ratio, and the shift of the position of a voltage minimum on the line is made when the unknown impedance is connected. The following formula may then be used

$$Z' = R_o \cdot \frac{1 + K}{1 - K} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where Z' = Unknown impedance.

R_o = Characteristic impedance of the measuring line.

$K = k\angle\phi$ = Reflexion coefficient.

All the above being complex quantities although for a well-made measuring line R_o is assumed resistive

$$\text{now } k = \frac{\text{S.W.R.} - 1}{\text{S.W.R.} + 1}$$

$$\phi = 2\Theta$$

where S.W.R. = standing wave ratio,

Θ = Shift of a minimum position.

If the position of a minimum shifts towards the load, when the load is connected, the angle of the reflexion coefficient is negative, and the load is capacitive.

To avoid the constant manipulation of the formula of equation (1), which is somewhat laborious unless a vector slide rule is available[1] a graphical solution may be obtained by the use of Smith charts[2]. These charts give answers of the same or a better order of accuracy than the measurement except in certain instances. Graphical plotting errors are likely to be large if:

(a) The angle of the reflexion coefficient is nearly equal to 0 or $\pm$ 180° and the standing wave ratio is greater than 5, particularly in the former instance.

(b) The standing wave ratio is less than 1·4.

These errors may be avoided if the sections of the Smith chart involved are available to a much larger scale (e.g., an expanded chart of the centre of the normal Smith chart).

A small shift of the position of a minimum ($\phi \simeq 0$) usually occurs when measuring impedances whose resistive component is greater than $5R_o$ and which are shunted by a large reactance. An approximate shift of 90° of the minimum position (i.e. $\phi \cong 180°$) will occur when measuring impedance whose resistive component is less than $R_o/5$ and shunted by reactance.

The former problem is often encountered as the characteristic impedance of measuring lines is low, usually between 50 and 150 ohms. Low standing-wave ratios are encountered when matching unknown impedances to transmission lines or waveguides.

To avoid large errors likely to occur when using the standard Smith's charts in the above quoted instances, and yet avoid the use of the vector equation (1); approximate formula involving scalar quantities only may be employed and these are as follows:

MEASURING HIGH IMPEDANCES

$$r \simeq R_o \text{ S.W.R.} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

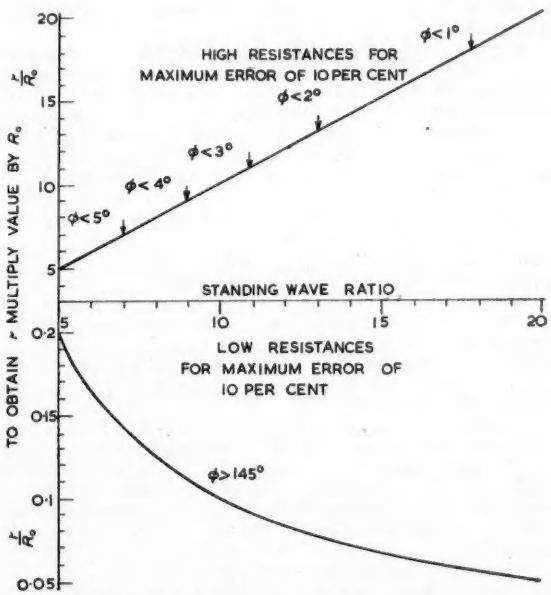
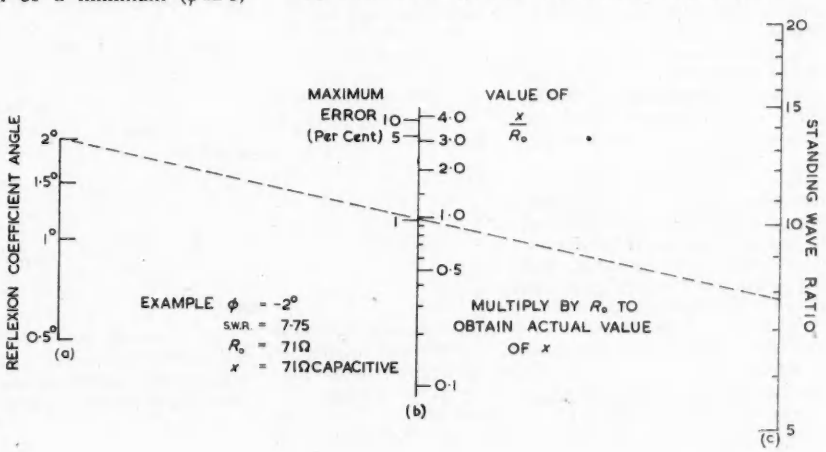


Fig. 1 (above). Graph for obtaining r when S.W.R. is large

Fig. 2 (below) Nomogram for series reactance of high impedances



* *The General Electric Company, Limited, Wembley, England.*

$$x \simeq R_0 \sin\phi(\text{S.W.R.}^2 - 1)/2 \quad \ldots\ldots\ldots\ldots\ldots (4)$$

for S.W.R. >5 $\phi<2$

MEASURING LOW IMPEDANCES

$$r \simeq R_0/\text{S.W.R.} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$x \simeq R_0 \cdot \tfrac{1}{2} \cdot \sin\phi \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

for S.W.R. >5 $\qquad \phi>140°$

MEASURING IMPEDANCES NEARBY EQUAL TO R_0

$$r \simeq R_0 \frac{\text{S.W.R.} + 1}{(\text{S.W.R.} + 1) - 2(\text{S.W.R.} - 1)\cos\phi} \quad (7)$$

$$x \simeq R_0\, 2 \sin\phi \left(\frac{\text{S.W.R.} - 1}{\text{S.W.R.} + 1}\right) \ldots\ldots\ldots\ldots (8)$$

for S.W.R. $<1{\cdot}3$

Where r and x are the series components of resistance and reactance.

The derivation of these formulæ and the limitations on their use are discussed in the Appendix and graphical or nomographic solutions are given in Figs. 1 to 4. In all these graphs and charts the values have been normalized with respect to R_0 the characteristic impedance of the measuring line, and to obtain the actual numerical value of r or x the value obtained from the chart should be multiplied by R_0.

In Fig. 1 the maximum error will be less than 10 per cent if the value of ϕ is less than shown in the various regions for high resistances, and if ϕ is greater than 145° for the low resistance section of the graph.

The nomogram of Fig. 2 is for the evaluation of the series reactance when the total series impedance is large compared to R_0.

The reflexion coefficient angle (scale A) is joined to the standing wave ratio (scale C) and the intersection on scale B gives the value of x/R_0. The intersection on scale B also gives the maximum magnitudes of the error which could be encountered. In the example shown an angle ϕ of 20°, and a standing wave ratio of 7·75 gives a value of $x/R_0 = 1$ with a maximum error of 1 per cent. The maximum error occurs for the larger value of ϕ; and for smaller values of ϕ the error is less for the same intersection on scale B.

For all the nomograms a negative reflexion coefficient (i.e., minimum moves towards load) corresponds to a capacitive reactance. Figs. 3 and 4 are nomograms for S.W.R. less than 1·3 and are used by joining scales A and C and obtaining intersections on scale B. The errors are as shown on scale B for Fig. 3, and the error has a maximum value of 25 per cent and occurs for a S.W.R. of 1·3 and $\phi \cong 0°$ or 180°.

It must, however, be remembered that at these low S.W.R. unless precision calibrated and corrected equipment is being used the inherent errors of measurement may be greater than 25 per cent.

Again it must be emphasized that the range of the nomogram scales has been selected to keep the errors to a reasonable order of magnitude, and the scales must not be extended in any direction.

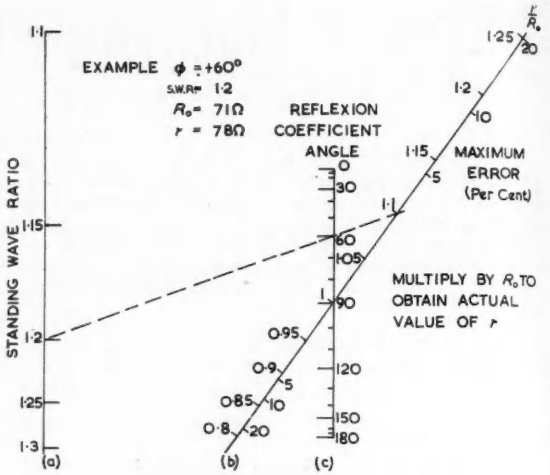


Fig. 3. Nomogram for series resistance for S.W.R. < 1·3

APPENDIX

$$Z' = R_0 \frac{1 + K}{1 - K} = R_0 \frac{1 + k\angle\phi}{1 - k\angle\phi}$$

$$= R_0 \frac{1 + 2\,\mathrm{j}\,k\sin\phi - k^2}{1 - 2k\cos\phi + k^2} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

HIGH IMPEDANCE CASE

here we assume $\phi \cong 0°$ and hence $1 - 2k\cos\phi + k^2$

$$\simeq 1 - 2k + k^2$$

$$r \simeq R_0 (1 + k)/(1 - k) = R_0 \text{ S.W.R.} \quad \ldots\ldots\ldots (3)$$

$$x \simeq R_0\, 2\,\mathrm{k}\sin\phi/(1 - k)^2$$

$$\simeq R_0 \sin\phi \cdot (\text{S.W.R.}^2 - 1)/2 \quad \ldots\ldots\ldots\ldots\ldots (4)$$

Now these approximations are only justified for certain values of ϕ and k and the nomograms and graphs must not be extended or these limits will be exceeded. The maximum value of the error is shown on the appropriate range of the charts.

LOW IMPEDANCE CASE

Here we assume $\phi > 140°$ and hence $1 - 2k\cos\phi + k^2$

$$\simeq 1 + 2k + k^2$$

$$r \simeq R_0 \frac{1 - k}{1 + k} \simeq \frac{R_0}{\text{S.W.R.}} \quad \ldots\ldots\ldots\ldots\ldots (5)$$

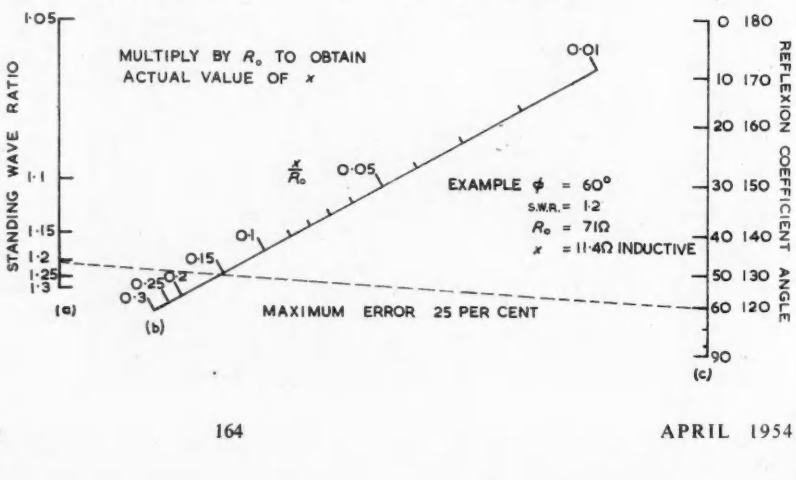


Fig. 4. Nomogram for series reactance for S.W.R. < 1·3

$$x \simeq R_0 \frac{2k \sin\phi}{(1+k)^2} \simeq R_0 \frac{\sin\phi}{2}\left[1 - \frac{1}{\text{S.W.R.}^2}\right]$$

and if S.W.R. > 5 we may neglect the $1/\text{S.W.R.}^2$ term

$$x \simeq R_0 \frac{\sin\phi}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

The maximum error is of the order 20 per cent.

LOW STANDING WAVE RATIO CASE

If S.W.R. $< 1{\cdot}3$ the k^2 term may be neglected and

$$r \cong \frac{R_0}{1 - 2k\cos\phi}$$

$$\simeq R_0 \frac{\text{S.W.R.} + 1}{(\text{S.W.R.} + 1) - 2(\text{S.W.R.} - 1)\cos\phi} \quad \ldots\ldots \quad (7)$$

for the evaluation of x the $k^2 + 2k\cos\phi$ term may be neglected, and the maximum error will be 25 per cent over the range considered. This error may seem large from a mathematical viewpoint; but considering the practical difficulties of measuring accurately low standing wave ratios, and shifts of minimum at these low S.W.R., the mathematical errors are likely to be less than the errors of measurement.

Then $x \cong R_0 2k\sin\phi$

$$\simeq R_0 2\sin\phi\left(\frac{\text{S.W.R.} - 1}{\text{S.W.R.} + 1}\right) \quad \ldots\ldots\ldots\ldots \quad (8)$$

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The Noise Performance of Television Receivers

By T. S. McLeod*, M.A., A.M.I.E.E.

Noise in television receivers is due to man-made interference, cosmic noise, and circuit noise, in that order of importance. Consequently performance depends chiefly upon the position and directivity of the aerial used, and input circuits are of secondary importance.

THERE are at present a great many television receivers in areas where the field strength of the signals is between 50μV/metre and 200μV/metre, and the quality of entertainment which they provide depends largely upon the aerials and input circuits that they use. The noise performance of high frequency receivers has received considerable attention in the last decade, a recent treatment being that of Hamer[1], and the purpose of this article is to discuss the points that in particular apply to the television receiver. This suffers seriously from man-made interference, to some extent from aerial or cosmic noise, and in some cases from receiver noise, and the object of design must be to reduce to a minimum the ratio of the total of these three to the received signal.

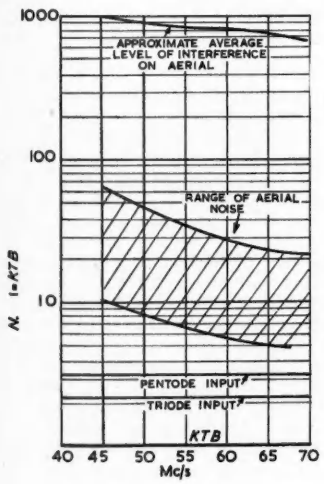

Fig. 1. Comparative noise power

The levels of the pentode and triode inputs shown in the diagram are 4·2 and 2·2

Man-made Interference

The most important single source of man-made interference is motor car ignition. This produces a wide band of radiation, part of which is picked up directly on the television aerial. The remedy is to mount an aerial of good directional properties as far as possible from a main road, and as high up as possible so as to increase the strength of the wanted signal. Buildings may provide a measure of screening, and it sometimes helps to turn the aerial slightly away from the transmitter if this also turns it away from the road. This is because the directional pattern is flat around its centre and the sides fall away sharply. Interference from domestic electrical appliances may be reduced in the same way.

Fig. 1 shows the comparative noise power due to the three sources mentioned. The level of interference shown is 10 to 15db below that described by Hamer[1] as being exceeded for one minute in every hour on average in England. The fluctuations in interference level are very large, and it seems reasonable to assume that for much of the time, particularly in the evening, levels will be at least as low as this, and that they will sometimes be much lower. It is clear, however, that this type of noise is much more

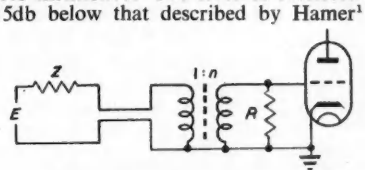

Fig. 2. Standard Input Circuit

* *Cottage Laboratories Ltd.*

serious than the others, and the essential problem of long range television reception is to reduce it to a minimum.

Aerial Noise

This consists of high frequency radiation believed to come from the stars, and it varies considerably with time, season, and the part of the universe at which the aerial is pointing. It will be seen from Fig. 1 that it is more important at the lower end of the television band, and at all frequencies varies by 7 or 8db.

The only protection is to use an aerial of good directional properties: any other means of reducing cosmic noise reduces the desired signal by the same amount.

Input Circuit

Standard British practice is to use an aerial with an impedance of 50 to 100Ω connected to the set by a cable of similar impedance[2], and to feed it to the grid of a high slope pentode through a step-up transformer[3]. Such an aerial may be represented as a constant voltage source in series with its characteristic impedance[4], so that the circuit can be represented as shown in Fig. 2. It may be shown that the voltage developed across the grid:

$$E_g = \frac{nER}{n^2Z + R}$$

(neglecting cable losses)

In practice it is difficult to achieve a value for n greater than 2 or 3, and under these conditions the greatest voltage is developed across the grid for the highest value of R. When R is infinite the voltage gain is 6db greater than that when the cable is matched, and it will presently be seen that the receiver noise figure will also be 6db better. It will be shown that this improvement will rarely have any appreciable effect upon overall performance, and will simply make it unnecessarily difficult to achieve an adequate input bandwidth. Most manufacturers compromise with a value of R of about $4n^2Z$, say 3 300Ω, which gives a gain and noise figure within 2db of the open circuit values, and yet provides a moderate match to the cable and makes it fairly easy to get an adequate bandwidth.

Receiver Noise

The noise produced in the receiver comes from four separate sources. The resistance R acts as a noise source of power kTB, k being Boltzmann's constant, T the absolute temperature, and B the receiver bandwidth. This will be developed across the transformed aerial impedance n^2Z, and will be small compared with valve noise. The valve noise is made up of shot noise due to fluctuations in cathode emission, partition noise due to random partition of the current between screen and anode, and transit time noise due to induction of voltages in the cathode grid circuit by fluctuations of the current between them. The effect of shot noise may be represented by a resistance of

$$R_s = 2{\cdot}5/g_m$$

in series with the grid lead, producing a voltage

$$E_s = \sqrt{4kTR_sB}.$$

Partition noise may similarly be represented by a resistance:

$$R_p = \frac{20i_{s^2}}{g_m{}^2} \times \frac{i_a}{i_a + i_{sg}}$$

where i_a and i_{sg} are anode and screen currents of the valve. Transit time noise is effectively damped out by the transformed aerial impedance, and may be neglected.

To quote an example a valve of the CV138(8D7) type will have equivalent noise resistances of 400Ω for shot and 800Ω for partition noise, so that its total equivalent noise resistance is 400Ω when it is used as a triode and 1 200Ω as a pentode.

Moxon[5] has shown that the noise figure of a valve in the circuit shown is:

$$N_r = 1 + r_a/R + R_n/r_a\,(1 + r_a/R)^2 \quad \ldots\ldots \quad (1)$$

where R_n is the equivalent noise resistance of the valve, and r_a the transformed impedance presented by the aerial at the grid. For $n = 3$, $Z = 75$ ohms and $R = 3\,300\Omega$ we have:

$N = 4{\cdot}2$ for a pentode
$N = 2{\cdot}2$ for a triode.

Overall Noise Figure

It is convenient to express both interference noise and cosmic noise in the same way as receiver noise by the multiple by which each exceeds the value of kTB, the theoretical minimum noise power to be found in a circuit at normal temperature. Then it may be shown that the overall receiver noise figure:

$$N = N_I + (N_A - 1) + LN_r \quad \ldots\ldots \quad (2)$$

where L is the loss factor in the aerial feeder expressed as the ratio of available signal power at the aerial to that at the receiver, and N_I and N_A are the interference and aerial noise figures. It must be remembered that while receiver and cosmic noise are continuous, interference is intermittent, and its importance depends upon the duration as well as the amplitude of the bursts in which it comes. Circuits which clip peaks and cannot be paralysed, and synchronization that is hard to upset, reduce the disturbing effects on the viewer of occasional interference, and the figure taken for N_I should therefore be well below its peak value.

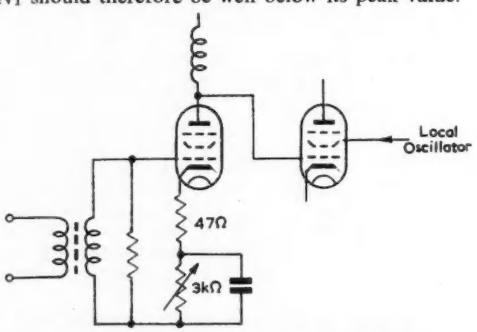

Fig. 3. Typical early stage of television receiver

Fig. 1 taken from values given by Hamer[1] and Moxon[5] for N_I and N_A shows that they will normally be much larger than LN_r, so that the input circuit of the receiver will be unimportant. Even in positions exceptionally free from interference N_A will usually be as high as 20 at 45Mc/s, and with a feeder loss of 2 (100ft of Uniradio 32) the difference between a pentode and a triode input will only be 28·4 against 24·4; less than 1db. At 66·75Mc/s aerial noise is appreciably lower, say $N_A = 10$, and the advantage of a triode over a pentode will be nearly 2db.

It is now possible to see how much feeder attenuation can be increased before receiver noise compares with interference, and thus to determine how far it is possible to reduce total noise by moving the aerial to a good position. Suppose that the receiver is close to a main road and that the interference noise level is about a figure of 1 000. If the aerial can be moved to a point some distance from the road, and screened from it by buildings, the interference level may well fall to a tenth of its previous value. If this requires 300ft of cable with a loss of 10db the contribution of receiver noise will be increased accordingly, and in place of:

$$N = 1\,000 + (N_A - 1) + 4{\cdot}2$$

we have:

$$N = 100 + (N_A - 1) + 42$$

The improvement will be 8 or 9db.

It will be noticed that the only effect of a pre-amplifier

close to the aerial will be to decrease the value of L in equation (2), and that this will only be useful when L is exceptionally high or N_I and N_A exceptionally low. In all cases the use of a triode instead of a pentode input is equivalent to the improvement due to moving a pentode input 100ft closer to the aerial.

Unnecessary Noise Sources

The early stages of a typical British television receiver[3] are shown in Fig. 3. The following points should be noted.

1. The 47Ω resistor in the cathode lead, placed there to reduce the effect of valve changing on the input circuit tuning, will increase the noise factor of the valve by 1db.
2. Reduction of the valve gain by the biasing control will further increase its noise factor, probably by about 3db for a gain reduction of 6db.
3. Unless the first stage has a gain of 16db or more the local oscillator noise will contribute appreciably to the overall receiver noise figure. This point may seem elementary, but the writer has experience of a popular commercial receiver in which the gain control precedes the local oscillator, and in a good service area the first stage acts as an attenuator. Local oscillator noise can always be seen on the screen.

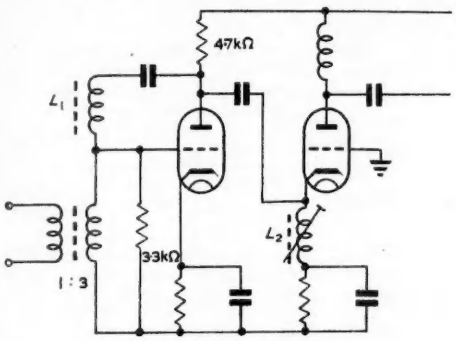

Fig. 4. Low noise input circuit
(L_1 and L_2 tune parallel strays at carrier frequency)

A Low Noise Input Circuit

It will be appreciated from what has been said that a special low noise input circuit is only justified when interference is low and feeder attenuation high. In these circumstances it may give an improvement in performance of 2 or 3db, and the circuit shown in Fig. 4, designed for use in Newcastle (for reception from Holme Moss), has received favourable reports.

Conclusion

1. The noise performance of a television receiver depends chiefly upon the position and directional properties of the aerial.
2. A pentode input is satisfactory, but it should be used at full gain in areas where the signal is weak, and should feed the mixer stage at a level adequate to swamp local oscillator noise.
3. Pre-amplifiers and special low noise circuits are of value only under exceptional conditions.

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4. TERMAN, F. E. Radio Engineers' Handbook, Sec. II (McGraw-Hill, 1953).
5. MOXON, L. A. Noise Characteristics of Rad r Receivers. *J. Instn. Elect. Engrs. 93*, Pt. IIIA, 1130 (1946).

New V.H.F. Broadcasting Transmitters for B.B.C.

In connexion with their plans for the introduction of V.H.F. sound broadcasting in this country, the B.B.C. have placed an order with Standard Telephones and Cables Ltd., for their latest type of Frequency Modulated Very High Frequency Broadcasting Transmitters. The order calls for twelve 10kW Transmitters type C.F.4 and twelve 1kW Transmitters type C.F.2.

These transmitters embody all the latest principles and practices of modern design. An important feature is an entirely new approach to the system of transmitter control ensuring the high standard of reliability essential to unattended Remote Controlled operation.

At each station, twin transmitters will be used for each programme so that either transmitter can be switched off without interrupting the service.

The B.B.C. has also placed an order with Marconi's Wireless Telegraph Co., Ltd., for the construction of 26 V.H.F. Frequency Modulated transmitters.

These transmitters, of Marconi design, comprising 24 of 4½kW power and two of 10kW, will form part of the B.B.C.'s plan to provide a powerful reinforcement to the coverage of its present medium and long wave stations, by the use of V.H.F. F.M. stations.

As envisaged, the 4½kW transmitters will operate in parallel pairs, each pair handling one programme. Thus, six of these transmitters will be used on each three-programme station. The two 10kW transmitters will be used in parallel at the B.B.C.'s existing V.H.F. station at Wrotham, where there are already two 25kW Marconi transmitters.

Nine Marconi station monitors have also been ordered by the B.B.C. for use on this project.

The Marconi transmitters, comprising units of basically similar design, but suitably arranged to provide the various output ratings, operate on the frequency-band 87·5-108Mc/s.

Air-cooled valves are used throughout, leading to a simplification of equipment, with reduced installation and maintenance costs.

The F.M.Q. drive unit used on these transmitters, employs a frequency-modulated quartz crystal, and supplies an output at the carrier-frequency. This signal is then amplified to raise it to the required output level, the number of amplification stages used depending on the rated power-output of that particular type of transmitter.

The initial R.F. amplification stages consist of a double tetrode stage, capacity coupled to a pair of tetrode valves, the anode circuits of which take the form of quarter-wave balanced lines magnetically coupled to a 50 ohms line, from which the output is taken at 250W.

A third amplifier stage is added (in this case a triode), for the 1kW equipment. The input is fed via the 50 ohm line to the cathode, the two cathode leads being at the same R.F. potential and forming the inner member of a tuned unbalanced line. The grid is grounded, and the anode circuit takes the form of a concentric line whose electrical length is varied by moving an R.F. short-circuit along the line. A tuned inductive coupling takes power from the anode line and feeds to the aerial termination.

For the 4½kW transmitter a further identical triode amplifier stage is added, while for the 10kW case yet another amplifier stage is used, employing two such arrangements in parallel.

A Time Base Oscillator

By C. H. Banthorpe*

MOST sawtooth voltage generators, or time-bases, have some particular merit, and it is sometimes difficult to decide which type is best for a particular application.

The sawtooth voltage generator for the line time-base of a television receiver should generate a voltage increasing linearly with time, have a short flyback time, be adjustable in frequency without a change of amplitude, lock readily to sync pulses, be unaffected by interference, and be reliable, simple and cheap.

A circuit which fulfills most of these requirements to a very high degree has already been described[1], but seems to have been little used so far.

Fig. 1 shows the basic circuit, the action of which is as follows:

When the circuit is switched on C_1 will have no charge, therefore g_1 of V_1 will be at earth potential. g_1 of V_2 will be at a positive potential with respect to earth, and its cathode potential will rise until it is just above g_1. Because

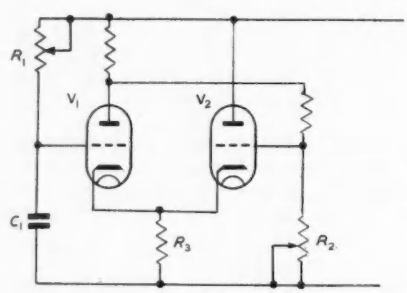

Fig. 1. Basic time-base circuit of Webb and Morgan

the cathodes of V_1 and V_2 are connected together V_1 will be biased well beyond cut-off. As C_1 is connected to H.T.+ by means of R_1 it will become charged and the potential across it will rise exponentially, the rate of rise being determined by C_1, R_1, and the H.T. potential. At some instant the potential on g_1 of V_1 will be sufficiently high to cause V_1 to take some anode current. When it does its anode potential will fall, causing g_1 of V_2 to fall also.

As V_2 takes less current, its cathode potential will fall, also the cathode of V_1, which is thus made to take much more current. This action is cumulative, the switch of current from one valve to the other being very rapid indeed. At this point g_1 of V_1 is positive with respect to its cathode and it will therefore take grid current which will discharge C_1. When C_1 is sufficiently discharged, V_1 will take less anode current, its anode potential will rise, g_1 of V_2 will rise and the potential of both cathodes will rise. V_1 will thus take still less current, and its anode potential will continue to rise. This action is also cumulative and the original state is reached with V_1 cut off and V_2 taking current. On the second and all subsequent cycles, however, C_1 does not commence to charge from a fully discharged state, as V_1 does not completely discharge C_1. R_2 is a convenient amplitude control and R_1 will control the frequency without a change of amplitude.

A negative pulse can be obtained across R_3 and a positive pulse can be obtained from the anode of V_2 if a resistor is connected in the anode circuit.

These pulses are useful for trace brightening or flyback blanking.

This circuit has already been used successfully as part of a divider chain[2], and has also been used by the author in a line time-base for a considerable time, with satisfactory results. Like the blocking oscillator and self drive line time-bases, it is remarkably free from the effects of noise and provides a picture with clean vertical edges.

If a time-base is adjusted so that it requires a large sync pulse, then it will be practically free from the effects of noise or interference from sync source, but the free

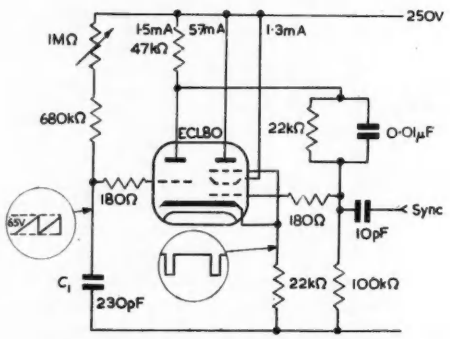

Fig. 2. Final circuit of line time-base oscillator

running speed will be very much slower than when locked and the amplitude will be greatly increased. This can cause serious trouble if a television receiver is operating with no signal due to station breakdown or shut down, or aerial or receiver failure, particularly if the E.H.T. is obtained from the flyback.

In the oscillator described the change of frequency and amplitude when the sync is removed is very small; less than 10 per cent. Fig. 2 shows the final circuit used as a line time-base oscillator. A standard modern valve is used for the purpose, and it is operated well within its ratings.

If other frequencies are required they may be obtained by changing the value of C_1 only, and the amplitude will remain constant. This feature is extremely desirable in oscilloscope time-bases and the circuit would appear to be particularly suitable for this purpose. It will operate over a very large range of frequencies and is easily locked.

* (*Derwent Television*), (*Central Equipment Ltd.*)

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2. BANTHORPE, C. H. A Circuit with Electrical Backlash. *Electronic Engng.* 26, 110 (1954).

Short News Items

The Royal Society of Arts have issued a list of the successful candidates in the Society's Industrial Art Bursaries Competition for 1953. In all 232 candidates entered from 60 schools and industrial establishments. A record number of 18 bursaries was awarded amounting in value to £2 400, which compares with £2 225 in 1952, and brings the total sum awarded in these competitions since 1946 to £11 740. In addition to their bursaries 9 winners will also be eligible for Associate Membership of the Society.

The German Industries Fair will be held in Hanover from 25 April to 4 May. Full details may be obtained from Schenkers Ltd, Shipping and Forwarding Agents, 27 Chancery Lane, London, W.C.2, who are the official agents in the United Kingdom.

The Scottish Committee of the Council of Industrial Design is holding a Design Congress on 26 and 27 May in the Assembly Rooms, Edinburgh. The theme of the Congress will be the promotion of design as a high level responsibility in industry, commerce and the public services, and a distinguished panel of speakers will be presented.

The Institution of Electrical Engineers held their annual dinner at Grosvenor House on 25 February when the President, Mr. Harold Bishop, was in the chair. The principal guest, Field Marshal the Rt. Hon. the Earl Alexander of Tunis, Minister of Defence, proposed the toast of "The Institution," to which the President replied. The toast of "Our Guests" was proposed by Colonel B. H. Leeson (immediate past-president), and the reply given by Sir Ian Jacob (Director-General, BBC).

EMI announce that, following his election as their representative on the Council of the Radio Communication and Electronic Engineering Association, Mr. S. J. Preston has now been elected Vice-Chairman of the Council.

The Swiss Post Office recently ordered three Emitron microwave links and these are to be augmented by a further three complete units. They will be used in connexion with the Anglo-European interchange of television programmes recently announced. Emitron links, which are employed by the BBC, are used to relay outside television broadcasts from location to the main transmitter.

Marconi Instruments Ltd, St. Albans, have increased the productive capacity of their Longacres works by the opening of a new factory wing. Several sections have been reorganized and a new design centre provides improved facilities for the company's engineers.

The BBC announces that the contract for the first stage of the building work at the new London Television Transmitting Station at the Crystal Palace has been placed with Higgs & Hill Ltd, Crown Works, South Lambeth Road, London, S.W.8. They also announce that contracts for the provision and erection of the masts for the transmitting aerials at the permanent medium power television stations at Rowridge (Isle of Wight), Pontop Pike and North Hessary Tor (South Devon), have been placed with British Insulated Callender's Construction Co. Ltd. Similar contracts for the provision and erection of masts for the permanent and medium power television stations at Divis (Northern Ireland) and Core Hill (near Aberdeen) have been placed with J. L. Eve Construction Co. Ltd.

The Joint Commission on Electron Microscopy is sponsoring an International Conference in its subject. At the invitation of the Electron Microscopy Group of the Institute of Physics, this will be held in London from 16-21 July this year. The Inaugural Meeting will be held at Senate House, University of London and the scientific meetings will be held at the London School of Hygiene and Tropical Medicine, Malet Street, London, W.C.1. The registration fee will be £2 for full members, £1 for friends accompanying them and for research students. All communications should be addressed to the Conference Joint Secretaries, Dr. C. E. Challice and Mr. F. W. Cuckow, c/o The Institute of Physics, 47 Belgrave Square, London, S.W.1.

The Council of The Institution of Civil Engineers announce that they have appointed Mr. Alexander McDonald as Secretary of the Institution, to succeed Mr. E. Graham Clark, C.B.E., who will be retiring this year.

Pye Ltd. have provided Keith Prowse with a mobile radio booking office, the first of its kind in the world. It is a 25cwt van, equipped as a ticket agency and is connected with the company's central clearing house by two-way V.H.F. radio. This mobile radio booking office will be going daily to markets, race meetings, sporting events and other similar gatherings.

Erratum. On page 131 of the March issue, in the description of the Capacitor Power Factor Measurement manufactured by Viduna Instruments, "150 to 150pF" should read "150 to 1 500pF".

PUBLICATIONS RECEIVED

READERS' GUIDE TO BOOKS ON RADIO AND TELEVISION is number 22 of a new series of select bibliographies now being published by the County Libraries Section of the Library Association. Each Guide is compiled by a librarian in co-operation with a recognized authority on the particular subject concerned. They may be purchased from the Honorary Secretary of the County Libraries Section of the Library Association, County Library, Widemarsh Street, Hereford, at 10d. a copy, plus 2d. postage. If over three copies are ordered, the price is 5d. a copy.

A HANDBOOK ON DIE CASTINGS has been prepared at the request of, and is issued by, the Advisory Committee (Die Casting) of the Ministry of Supply. While the publication was intended primarily as a Service handbook, the Committee considered the contents would be of considerable interest to industry. Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2, price 6s.

HOW TO TROUBLESHOOT A TV RECEIVER discusses how to find the cause of trouble in a television receiver in the shortest time. Part of the presentation includes lists of the equipment, tools and accessories required for receiver servicing. John F. Rider Publisher, Inc., 480 Canal Street, New York 13, N.Y. Price $1.80.

THE STRUCTURE AND MECHANICAL PROPERTIES OF COPPER - MANGANESE - TIN ALLOYS is a booklet recently issued by the Tin Research Institute. It describes a range of new alloys which may be useful in the fields hitherto served by nickel silver. The publication gives detailed information on the properties of a wide range of compositions and indicates how compositions and methods of treatment may be varied to give strength, colour or deformability, etc., as may be required. International Tin Research and Development Council, Fraser Road, Perivale, Greenford, Middlesex.

SUPPLEMENT NO. 1 TO RAGOSINE MOLYBDENISED LUBRICANTS describes new grades of molybdenum disulphide lubricants covering dispersions in water, volatile fluids and lubricating oils. The leaflet also mentions for the first time "Molysil" greases which combine the stability of silicone with the low coefficient of friction of molybdenum disulphide. Ragosine Oil Co. Ltd., Ibex House, Minories, London, E.C.3.

WIGGIN NICKEL ALLOYS NO. 22 contains articles on precision casting of the Nimonic alloys, uses of Monel in electric motors, fine bore tubing in nickel and high-nickel alloys, uses of Inconel in a submerged combustion device, exhaust valves in Nimonic 80 and fusion cutting of high-nickel alloys. Copies of this journal are obtainable, free of charge, from Henry Wiggin & Co. Ltd., Wiggin Street, Birmingham, 16.

ALDEN'S HANDBOOK gives the overall designs and components to build electrical or electronic equipment using plug-in unit construction. Alden Products Company, 117 North Main Street, Brockton, Massachusetts.

COURS PRATIQUE DE TELEVISION is a booklet for all technicians, engineers and students who are interested in the workings of a televisor and its installation. Editions Techniques et Professionnelles, 18 bis, Villa Herran, Paris 16.

BULGIN COMPONENTS is a catalogue of electrical and electronic components of interest to traders, factors, manufacturers and amateurs. This edition has been completely revised and redesigned to facilitate the location of components and the reading of data. Price 1s. post free. A. F. Bulgin & Co. Ltd., Bye Pass Road, Barking, Essex.

R.E.C.M.F. EXHIBITION PREVIEW

A description of selected exhibits at the Exhibition of the Radio and Electronics Component Manufacturers Federation to be held in the Grand Hall, Grosvenor House, Park Lane, London, W.1, from April 6–8.

(Figures in parenthesis refer to Stand Numbers.)

Advance Components Ltd. (11)

ON this stand will be shown the company's range of signal generators, attenuators and constant voltage devices.

The items that are of particular interest this year will be a Signal Generator Type D.1/D which is a new version of the existing instrument Type D.1 and has now been modified so it is directly calibrated, showing also for the first time will be a U.H.F. Piston Attenuator Type A.57 which is the same as that used in Signal Generator Type L.1.

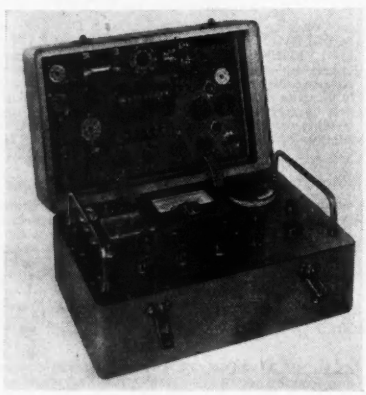
The attenuation range is 126db. The attenuator drive spindle rotates through 270° between extreme attenuation settings.

A crystal diode is built into the output of the attenuator together with a non inductive capacitor, so that the output voltage can be read directly if a calibrated microammeter is connected to the tags provided. A 75 ohms resistor (non-inductive) is inserted between the output socket and the crystal diode, so that for practical purposes the output presents a source impedance of 75 ohms.

Advance Components Ltd,
Shernall Street,
London, E.17.

Avo (111)

THE range of this Company's products is today so wide, that it is impossible to show very much more than the latest developments.



Of particular interest this year is the new "AVO" High Voltage D.C. Multiplier, and the "AVO" Valve Tester Type 160, a new pan-climatic, simple-to-use Valve Tester. This is illustrated above.

The Automatic Coil Winder & Electrical Equipment Co. Ltd,
Douglas Street,
London, S.W.1.

Bulgin (46)

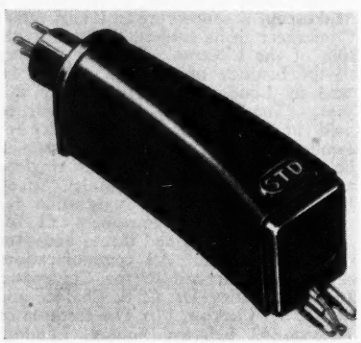
MANY or all of the standard products of this company are now specially made in materials and finishes to special specifications (such as RIC/1000, RCS/1000, etc.) where such is called for and also in general "Tropical" versions, civil grade.

The wide range of components has been extended and among the new products are the Bulgin "PolyMicrO" units, groups of up to 12 standard Bulgin Miniature Micro-Sensitive Switches ganged between brackets, with rotary-cam operation by shaft, and with or without indexing of positions, for manual or mechanical drive. These provide robust mains selector-switches of high rating, small size, for a life of ½-million or more operations.

A. F. Bulgin & Co. Ltd,
Bye Pass Road,
Barking, Essex.

Cosmocord (76)

THE main feature of the Acos stand will be the latest "Hi-g" series of pick-ups and pick-up cartridges which are designed to track with ease any modulation that is ever likely to be engraved on a gramophone record. A complete



series of cartridges and pick-up heads will be shown including cartridges suitable for incorporating into any of the latest, and most of the older, types of gramophone units. Illustrated above is the Acos HGP.35-1 pick-up head.

Also on show on the Acos stand will be the latest addition to the new range of microphones for use with tape recorders, public address systems, etc.

Cosmocord Ltd,
Enfield, Middx.

Daly (105)

THE Daly range of electrolytic capacitors has been further extended in the three main fields of Television and Radio, Specialized Electronics and A.C. Motor Starting. In all three, sizes have been reduced and characteristics improved particularly as regards operation at extreme temperatures. (−40°C. to +85°C.)

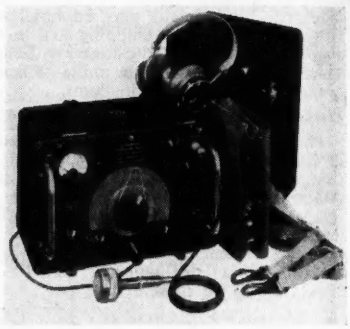
Many new types have been added to the Television class offering capacitance values up to 300μF in single compact units. The Daly Twist Prong single and multiple miniature units with international standard fixing, now cover a large variety of capacitance and working voltage values.

Daly (Condensers) Ltd,
West Lodge Works,
The Green, Ealing,
London, W.5.

Dawe (73)

TWO new instruments will be exhibited by Dawe. They are:

(1) Type 1408 Sound Level Indicator. This is a very compact model, covering



the range 40 to 130db. and provides a simple means of comparing the intensity of similar sounds and making preliminary investigations—for example, determining the best siting of P.A. loudspeakers in difficult locations, etc.

(2) Type 1101 Ultrasonic Thickness Gauge (*illustrated above*). Demonstrations will be given of this new model gauge used for the measurement of thickness of materials by means of high frequency sound waves. It has been especially developed for application where one surface only is accessible.

The range of measurement is from 1/16 in. to 12 in. of steel with an accuracy of ±3 per cent.

Special crystal units can be supplied to improve the accuracy of measurement on curved surfaces.

Dawe Instruments Ltd,
99 Uxbridge Road,
Ealing, London, S.W.5.

Dubilier (69)

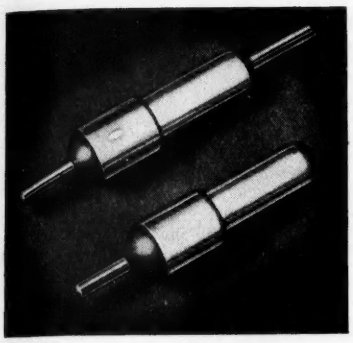
IN addition to Drilitic, Electrolytic, Nitrogol Paper, Moulded Stacked and Silvered Mica Capacitors, the following will be exhibited.

1. An entirely new range of High K ceramic dielectric varnish protected tubular capacitors for general radio frequency application and a new type of fully-sealed metal encased tubular High K ceramic capacitor in both stand-off and bushing forms, which at frequencies even in excess of 150 Mc/s still act as capacitors. This latter form is suffi-

ciently well sealed to meet Class H.2 requirements of the Joint Service Specification.

Illustrated are stand-off and bushing capacitors in this range.

2. Super tropical paper tubular capacitors—4800C range—capable of meeting Joint Service Specification Grade A (100°C.) Class H.1 (84 days' tropical



exposure) and R.I.C. Specification Red Grade. These capacitors have sustained without failure an endurance test exceeding 3 000 hours at 100°C. with working voltage applied.

3. Duconol Capacitors for A.C. application, fitted into aluminium containers, which are sealed by a special process novel in capacitor manufacture. The design and manufacturing process of these capacitors has enabled substantial reductions in weight and dimensions to be made whilst providing for a higher working temperature than has been possible hitherto.

Dubilier Condenser Co. (1925) Ltd, Victoria Road, North Acton, London, W.3.

Electrothermal (88)

ELECTROTHERMAL Engineering Limited are exhibiting their range of Valve Retainers to which a number of new types have been added. Noteworthy are the new Valve Retainers Cat. No. VRA.6 and 7 for miniature valves without anodes, and a Valve Retainer to be used with the new Top Cap Connector Cat. No. TC/4 for miniature valves with anode.

The "Precistor," a high stability wirewound resistor with the unique stability of 0·1 per cent, is also on show, together with the new wiring jigs for B7G and B9A valve holders.

Electrothermal Engineering Ltd, 270 Neville Road, London, E.7.

AB Metal Products (33)

ON this stand will be exhibited the Clarostat Range of Composition Element Potentiometers incorporating the Clarostat Stabilized Element.

New, also, will be Clarostat Series KS "Standee" above-chassis mounting power resistors, mounted vertically by one fixing above the chassis. The heat is allowed to dissipate in a harmless manner and the terminals protrude through the chassis for ease of wiring.

A comprehensive range of rotary switches in standard and miniature sizes, with ceramic and S.R.B.P. insulation will be displayed together with the Minibank Switch which still holds pride of place as the smallest Multi-Pole Switch in the world.

AB Metal Products Ltd., 16 Berkeley Street, London, W.1.

Belling-Lee (55)

THE "Belling-Lee" range of components and accessories for the Electronics, Radio and Electrical Industries has been further strengthened by the introduction of new lines and the redesign of some established lines. Hard gold plating has been added where appropriate.

The general purpose instrument fuselink, L.1055 is now manufactured by an entirely new technique which bonds caps, glass and filament into one unit, caps being so securely held that they will not come off unless the glass is broken. Average ratings are from 60mA to 25A.

A new range of six fuseholders for Inter-Service use has been developed, and in addition to the existing types of sealed and neon indicating versions, forms a very comprehensive range.

Screened plugs and sockets with 4, 6 and 12-way assemblies have been introduced. Assemblies are interchangeable with existing screened coaxial types.

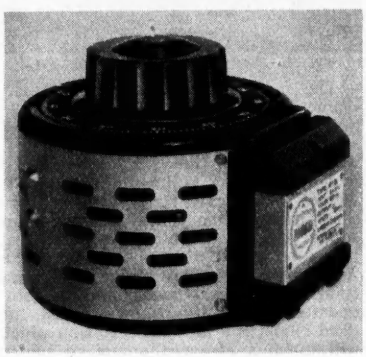
Belling & Lee Ltd., Gt. Cambridge Road, Enfield, Middx.

Berco (28)

THREE new components of outstanding interest to manufacturers of electronic and allied equipment will be introduced. They are:—

1. The Berco Rotary Regavolt continuously variable transformer, toroidally wound and having a brush rotated by a knob. Made in two sizes, 0·8 and 2 amp rating, they will be the smallest variable transformers available in this country and, therefore, can be built into electronic equipment (*illustrated*).

2. A range of five sizes of toroidal-wound power-type Rheostats 20-100



watts rating. The outstanding characteristics are:—

(a) All Porcelain construction.

(b) Windings embedded in Vitreous Enamel.

(c) Use of Silver Graphite as a brush contact.

(d) A wide range of accessories to provide ganged assemblies and ventilated cases are available.

3. A range of three plastic-moulded collet fitting knobs.

The British Electric Resistance Co. Ltd., Queensway, Ponders End, Middlesex.

Erie (15)

THE already wide range of Erie temperature compensating ceramicons has been still further expanded by the introduction of two new sizes of tube, and the introduction of the well-known Erie type-approved phenolic insulation as an optional finish.

The expansion of the existing range of tubular units, together with the introduction of miniature disks, is intended to meet the demands of manufacturers who are designing round the recently announced plans for F.M. and multi-channel television at very-high- and ultra-high-frequencies.

Allied to the above, and to meet the demands for top-end coupling, oscillator-coupling, and similar functions calling for small values of capacitance with very close tolerances, Erie have introduced the "Gimmicon" and the Type K.A. ceramicon, of which the common features are a capacitance range of 0·5pF to 10pF, and a standard tolerance of ±0·1 pF to ±0·2pF. The prices of these units, by virtue of highly mechanised production, are considerably lower than any other close tolerance ceramicon hitherto produced. The "Gimmicon" is fully insulated and extremely small in size, and, the Type K.A. ceramicon is non-insulated, but slightly larger; both having relatively large diameter axial leads.

Erie Resistor Ltd., The Hyde, Hendon, London, N.W.9.

Ferranti (16)

AMONG the new products on this stand is a range of 3cm and 10cm TR cells. Their characteristics are as follows:

TTR.31. A tunable Q T.R. Cell for use with $\frac{7}{8}$in. diameter circular waveguide. Frequency Range 9 100-9 900 Mc/s. Band width 5Mc/s. Handling Power 50kW peak.

TTR3.31MR and TTR.31MC. Tunable medium Q T.R. Cells for use with standard American waveguide (TTR. 31MR) or $\frac{7}{8}$in. diameter circular waveguide (TTR.31MC). Frequency Range 9 100-9 900Mc/s. Band Width 25Mc/s. Handling Power 50kW peak.

Ferranti, Ltd., Hollinwood, Lancs.

Goodman (12)

A NEW type of Permanent Magnet Focusing Unit will be on show. This unit, which employs new features in picture focus and shifts, is being used by British Television manufacturers and is now available to the home constructor.

There are three constructions applicable to this design, type 12/44, 14/44 and 16/44, all of which utilize the new Ferroxdure magnetic material that has the advantage of high resistivity, enabling the units to be positioned close

to the deflector coil without affecting the performance of the set.

Goodmans Industries will also be showing an omni-directional sound diffuser Model C.D/77. This unit houses a high flux permanent magnet 10in. loudspeaker and has provision for an internal line transformer.

A small version of the C.D./77 type C.D./66, has been developed and will also be on show. This unit houses a high flux permanent magnet loudspeaker.

Goodman Industries Ltd.,
Axiom Works,
Wembley, Middlesex.

Hunt (44)

RECENT developments include a range of Electrolytic Capacitors of high-ratio anode construction, approved to new Inter-Service standards RCS134 issue 3 and RCL134 Addendum Issue 2; special types for Television applications; for High Temperature operation and miniature Electrolytic tubulars for diminutive apparatus.

In miniature metallized paper capacitors the midget W99 is now available for use up to 85°C. Thermetic-cased midgets are for operation from −100°C to +120°C.

New developments in Mica construction are Miniature Stacked Foil and Silvered types.

A. H. Hunt (Capacitors) Ltd.,
Bendon Valley,
Garratt Lane,
Wandsworth, London, S.W.18.

L.E.M. (42)

IN addition to the range of L.E.M. protected silvered mica from 1pF up to 2μF, there is now the new "Catacon" range of moulded silvered mica capacitors. These are fully Inter-Service approved to the 40/100 H1 Specification. Types CMM1-G and CMM3-Y cover the Ministry Specification RCL.132 up to 10 000pF and a range of moulded filter extends the range up to 250 000pF.

The Type 1106 sub-miniature "sintered" type silvered mica has been designed to meet stringent requirements of stability in circuits where small size and high performance are essential.

The range of F.E.C. ceramic capacitors now covers temperature compensating types for 1pF to 500pF and in tolerances as low as ±½pF, and a range of High K Tubes and Disks for up to 200Mc/s. These are especially suitable for inclusion in television receivers.

London Electrical Manfg. Co. Ltd.,
Beavor Lane,
Hammersmith, London, W.6.

Mullard (65, 108, 109)

A RANGE of AM/FM valves for VHF broadcast receivers will be shown for the first time. Included in the range are VHF double triode, type ECC85; a triple-diode-triode EABC80, for use in ratio detectors; a versatile triode-heptode, type ECH81; and a high-slope (6·5mA/V) variable-mu, RF pentode EF85. These valves lend themselves to a variety of circuit arrangements, thus making possible the efficient and economical reception of both AM broadcasts, on the lower frequencies, and FM broadcasts on the very-high frequencies (i.e. 87·5-100Mc/s).

Junction triodes will be shown for the first time. The OC10, OC11 and OC12, are intended for circuit experiments, while the OC70 and OC71, which are hermetically sealed in glass, are high-gain, high-stability types. Two point-contact transistors, the OC50 and OC51, will also be shown. In these, the contact spacing has been varied to give markedly different characteristics.

New hermetically sealed germanium diodes include the OA71 and CV448, with high back resistance, and the high efficiency RF detector OA73/CV442.

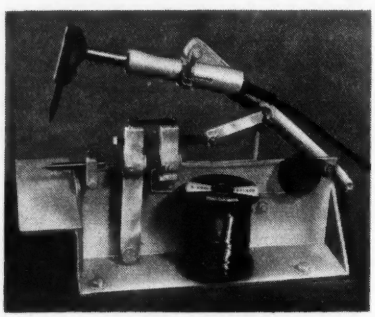
The new OA70 television detector and the OA61 D.C. restorer and pulse clipper will also be shown.

Mullard Ltd.,
Century House,
Shaftesbury Avenue,
London, W.C.2.

Multicore (66)

A NEW exhibit on this stand will be an automatic soldering head designed for repetition soldering processes of small parts.

Solder drawn from a 7lb. reel is automatically fed above the components to be soldered and an electrically-heated iron automatically descends and solders the components concerned. The standard iron supplied has a long-life 80 watt element and a minimum temperature of 300°C at the end of a 2in. long (adjustable) bit, ⅛in. diameter. Alternative size bits and irons can be supplied to special order.



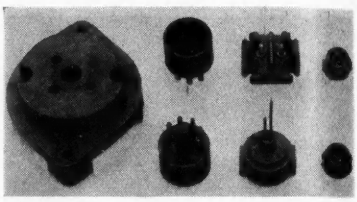
The machine will accommodate any diameter of Multicore Solder between 13 and 19 s.w.g. and feed any length of solder between 1/32in. and ¼in. per movement. This new machine, designed and produced by Multicore Solders Ltd., Hemel Hempstead, Herts, can be supplied in three models. One model is supplied with no motive power so that it can be linked with an existing manufacturing process. Another is supplied complete with a bench and a foot-operating pedal (*illustrated*), whilst the third model is a motorized version which will make joints at the rate of up to 3 000 per hour.

It should be emphasized that these machines are intended for manufacturing processes involving soldering and are not suitable for radio servicing.

Multicore Solders Ltd.,
Maylands Avenue,
Hemel Hempstead, Herts.

Mycalex (86)

"MYCALEX" is the trade name for patented Glass Bonded Mica insulation manufactured from glass and mica compounded under heat and pressure. It is supplied either as a finished article moulded to shape, or in sheets and rods machined to requirements.



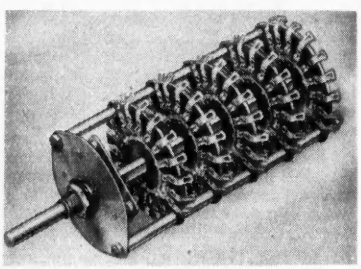
Recent developments have resulted in an insulator with greatly improved electrical qualities. This will be marketed under the name of "Mycalon." The power factor has been reduced to 0·001.

Illustrated is a range of moulded components made from "Mycalon."

Mycalex Co. Ltd.,
Cirencester, Glos.

NSF (61)

NEW products include the 18 position type DL (*illustrated*) and the nylon type NDH wafer switches, a tandem dual



concentric spindle carbon track volume control type CP3 and miniature pre-set carbon potentiometer type CP9. Both these latter items have been specially developed for television receivers.

NSF Ltd.,
9 Stratford Place,
London, W.1.

Painton (27)

AMONG the 1954 New Range of Painton Components are the following units.

The New PW2 Series of Midget 2-watt Wirewound Potentiometers. Generally for RCL121 Type approval, with the progressive feature of a split collet spindle locking device which is integral with the mounting bush.

The full "Bembridge Series" of Knobs is shown for the first time, the design based on the already proven studio control knobs as used by the B.B.C.

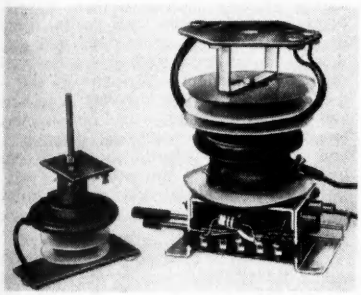
Extending the existing range of Painton Push-Button Switches is the introduction of a heavy duty push-button switch with provision for panel sealing if required.

Painton & Co. Ltd.,
Kingsthorpe,
Northampton

Plessey (67)

A NEW and interesting television component is the Multi-Channel Tuner, designed to cover frequency bands I and III. This tuner, of the turret type, can be used to select any number of channels, up to a maximum of 12, within the two bands, covering the International television channels for export television requirements and also the proposed home commercial TV range. It thus makes adequate provision for any future increase in Channel availability in Band III for home use.

Among television components a new development in high insulation scan coil technique is the polythene insulated high impedance coil which is of particular value in "direct drive" circuits. In conjunction with this component are two designs of E.H.T. transformers of the "direct drive" type giving a range of 9-14 kV EHT. The application of the Schade type of linearity control to direct drive circuits has resulted in the attainment



of a horizontal linearity figure of the order of 5 per cent, and the development of a new frame circuit design has resulted in a similar order of linearity in vertical scan.

The illustration shows Line-EHT Scanning Transformers with the conventional auto-transformer design on the right and a new design for direct drive on the left.

The Plessey Co. Ltd.,
Ilford, Essex.

Steatite (54)

NEW materials shown include Faradex H, a stable high permittivity ceramic (K = 3200), for by-pass capacitor manufacture; this ceramic has a very small variation of permittivity over the whole temperature range called for in Services requirements.

Another new ceramic at present available in limited quantities is Frequentite S, a steatite-type material of extremely low dielectric loss ($\tan\delta < 0{\cdot}0002$). The mechanical properties and absolute freedom from porosity of this material renders it particularly suitable for vacuum applications, e.g., for envelopes of UHF valves, magnetron windows, etc.

Steatite and Porcelain Products Ltd.,
Stourport-on-Severn,
Worcestershire.

Stocko (99)

THE "Stocko" range has expanded over the past years due to the ever-increasing demand for intricate pressed and draw work required by the radio and electronic industries.

Standard items include, eyelets, single and double-ended eyelet tags, flat solder and contact tags, wired caps, end caps, wired eyelets, fluted caps, ferrules, pillar lugs, etc.

Stocko (Metal Works) Ltd.,
Queensway, Ponders End,
Middlesex.

Stratton (10)

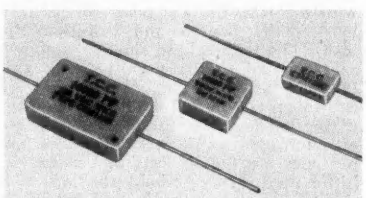
A NUMBER of new components have been introduced, and attention is drawn to the Cat. Nos. 551, 552 and 553 Miniature Microdensers which will undoubtedly have many applications in compact VHF equipment. There is also a new range of I.F. and Discriminator Transformers, whilst the range of Knobs has been increased.

Stratton & Co. Ltd.,
Alvechurch Road,
Birmingham 31.

T.C.C. (17)

IN order to comply with the requirements of Inter-Services Specification RCS.132 Category 40/100, H.1, Moulded "Plimoseal" Silvered Mica Capacitor has been introduced. This method of protection not only prevents the ingress of moisture, it also improves the insulation resistance and power factor, without impairing the inherent stability of the capacitor unit. This series, which is illustrated, conforms in every way to RCL.132 and will ultimately be available in all capacitances and sizes quoted therein.

The latest addition to the Hi-K Ceramic Group are the Miniature Lead-Through Capacitors which will be of especial interest to designers of TV receivers for Bands III/IV. They have a capacitance of 1 000pF, and are in-



tended for soldering on to a chassis or sub-assembly.

A new range of Metallized Polystyrene Capacitors is now available in Tubes and Metal Cans which has considerably enlarged the scope of these condensers.

For capacities of $0{\cdot}005\mu F$ up to $0{\cdot}5\mu F$, a tubular construction is usually adopted: above that metal cans with glass terminals are used.

The Telegraph Condenser Co. Ltd.,
North Acton, London, W.3.

TMC (26)

AN innovation this year will be a display of capacitors covering the complete equipment requirements of a portable Radar station. Among the various types shown will be, at one end of the range, H.T. capacitors for 7kV D.C. working, housed in welded steel cases, while at the other end will be so-called "Blister" types for circuit de-coupling, bulking no larger than a cubic inch.

Polystyrene capacitors, continuing to find new fields of exploration, will be represented by specimens of the standard range and of a new range developed for A.C. working. New case styles and mounting methods, that keep pace with the new circuits that go with Polystyrene, will be shown including samples of the "Potted Circuit" technique and its application to composite Polystyrene capacitor blocks.

Telephone Manufacturing Company Ltd.,
Hollingsworth Works,
Dulwich, London, S.E.21.

Telcon (78)

TO the well-established range of Telcon helical membrane coaxial cables has now been added a duplicate series of 50 ohm coaxials, together with a new 75 ohm cable of 1¼in. diameter—the HM.7.A1.

Further work has been carried out on the design and development of screened quad cables for television relay systems and other new exhibits include a cable with a corrugated outer conductor and another showing an extruded screen of resistive material.

Telegraph Construction & Maintenance
Company Ltd.,
Telcon Works, Greenwich,
London, S.E.10.

United Insulator (8)

U.I.C's range of products has been added to this year by some unique designs in chassis furnishings which offer scope for new applications, saving space and money. Other new items include an I.F. Transformer Former in low loss ceramic, and several additional ranges of Fuses.

Two new materials will be on show: "Unilite" the new low-loss insulator especially produced for R.F. applications and "Unilain" the new high-grade porcelain, particularly suitable for high stability resistor formers.

Also on show is U.I.C's range of metallized terminals which are now being produced by a recently developed nickelizing technique.

United Insulator Co. Ltd.,
Oakcroft Road,
Tolworth, Surbiton, Surrey.

Welwyn (58)

NEW components on this stand will include the following:

(1) "Panclimatic" range of cracked carbon resistors which have an improved protective lacquer, giving an excellent performance under tropical conditions.

(2) A resin encapsulated form of cracked carbon resistor which provides an insulated component.

(3) Metal film resistors in the conventional tubular form.

(4) Toroidally wound Potentiometers for power applications.

(5) Ceramic Terminal Seals in the Inter-Services range of approval sizes.

(6) Resin Encapsulated Precision Wire Wound Resistors.

Welwyn Electrical Laboratories Ltd.,
Bedlington Station,
Northumberland.

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BOOK REVIEWS

Circuit Theory of Electron Devices

By E. Milton Bone. 483 pp., 120 figs. Demy 8vo. Chapman & Hall Ltd. 1953. Price 68s.

SO many books have been written on radio engineering and electronics that there is a tendency to say "What, another!" and to look to see whether a new book gives a fresh approach to established theory or contains new material. The chief recommendation for this book is that it contains a 50-page chapter on transistors though this does not go beyond the scope of popular articles in the technical press. The rest of the book deals with telecommunications component circuits in no new way, and covers much the same ground as many well established American textbooks.

Chapter I, on diode and triode valves, contributes a somewhat verbose introduction and some sentences have to be reread to get the real meaning. For example on page 5, di_b/de_b is constant and equal to the variational conductance of the element. It would be preferable to substitute "A.C." for "variational." On page 10, surely the third electrode does not permit the "free passage of the electrons through the spaces between the grid wires"; its potential controls and restricts the number passing through. The student may find the introduction of $\sqrt{2}$ in expressions on page 29 confusing; if it is felt necessary to refer to maximum values a special symbol is available and recognized. Fig. 1.21 does not agree with the text, the A.C. peak voltage is 4 volts in the diagram and 2 volts in the text. The load eclipse should be shown as tangential to the negative peak grid line and not cutting it. Apart from the equivalent circuit and load line treatment of the triode valve, there are two pages on photosensitive devices. Tetrodes and pentodes are the subjects of Chapter II. Little need be said about the next two chapters on voltage and power amplifiers. Push-pull operation and negative feedback are examined; there is also a section on video frequency amplifiers. For the chapter on "Gas filled tubes" the author very wisely starts from the high vacuum diode and points out in the text that the diode has a saturation current for a given value of heater voltage; unfortunately this is in conflict with the valve characteristic (Fig. 5.1) used to illustrate it. Some reference to the indeterminate action of oxide coated cathode would have put this in perspective. Single and three phase rectifiers are dealt with next, and again we find evidence of carelessness in preparation of diagrams. Fig. 6.1 c. and d. look much the same apart from the delay time of the "gas tube" and yet the i_b, e_b characteristics are quite different. The scale of Fig. 6.1e has been made to fit the diagram after the latter was drawn so that O to π is about 30 per cent greater than π to 2π. The analysis of the power efficiency of the half-wave rectifier would have appeared much simpler had the author used the fact that power input is the product of the R.M.S. input of secondary voltage and the R.M.S. fundamental component of current, i.e. $(E_m/\sqrt{2})(I_m/2\sqrt{2})$.

Tuned R.F amplifiers (narrow and broad band) are considered in Chapter VIII. It is important to avoid confusing critical coupling with the coupling (sometimes called optimum) giving maximum voltage output from coupled tuned circuit. The two are not identical when primary and secondary Q factors are unequal and critical should be reserved for the coupling just avoiding double peaked response. Passing mention is made of wide band coupled circuits and to their improved frequency response and gain, but there is no reference to their greater overshoot to a transient. Chapters IX and X are concerned with R.F. power amplifiers and oscillators. Fig. 10.5 is another example of badly executed diagram I_p and I_L vectors are repeated and the lengths changed in the process.

After modulation and demodulation have been dealt with, we come to the last chapter on transistors.

K. R. STURLEY

Kempe's Engineers' Year Book 1954

1345 and 1413 pp. Crown 8vo. Two volumes (in case). 59th Edition. Morgan Bros. (Publishers) Ltd. Price 75s.

THE fifty-ninth edition of this book which has just made its appearance is noteworthy in that the whole of the book has been rewritten and reset in a new type face.

Every chapter except one, which is waiting further deliberations by the British Standards Institution on the particular subject, has received a major revison and a vast amount of additional matter has been introduced so that many of the existing chapters are virtually new.

There are eight new chapters, bringing the total number up to 79, and with every justification the publishers can claim that every aspect of mechanical, civil and electrical engineering is covered in these two volumes.

It is, of course, beyond the capabilities of a single reviewer to comment on the book as a whole but "Kempe" has been so long with us—it was first published in 1894—that as a source of reference it is a "must" for the engineer's bookshelf. It is a remarkable tribute to its longevity that at least three generations of engineers have been brought up on "Kempe."

The chapter entitled "Radio Communication" in the earlier editions has been completely revised and now appears under the heading "Electronic Engineering" which is more in keeping with the times and is indicative of the way in which this particular branch of engineering is expanding. The reader will

find much that is missing in this chapter but this is in no sense a criticism for electronic engineering is now such a vast subject that to give adequate treatment would take up the whole of the available space in Kempe and no doubt this applies equally well to the other principal subjects dealt with.

The best possible use is made of the 24 pages allocated to electronic engineering, but no more than a brief survey can be made with a pause here and there to emphasize a particular facet.

Methods of Theoretical Physics

By P. M. Morse and H. Feshbach. Part 1, 998 pp., 153 figs. Part II, 980 pp., 75 figs. Royal 8vo., McGraw-Hill Book Co., Ltd. 1953. Price £12.

THIS magnificent treatise has been in preparation for over eight years and represents the achievement of two professors of physics in the Massachusetts Institute of Technology. The primary purpose of the work is to present a detailed exposition of the mathematical processes which have proved to be most effective in the calculation and analysis of the many kinds of fields encountered in modern physical theory. It provides an extensive account of the methods available to physicists for finding the particular solutions of certain partial differential equations of field theory which correspond to prescribed boundary conditions.

The work occupies two volumes. The first volume begins with a discussion of the properties of scalar and vector fields and their representation in various coordinate systems. This leads to a comprehensive treatment of the mathematics of field theory. The subjects introduced include vector analysis, tensor calculus, dyadics, quaternions, spinors, and the spacetime manifold of special relativity. In the second and third chapters the more important partial differential equations of theoretical physics are derived. These include the wave equation, the Laplace, Poisson, Helmholtz, Klein-Gordon, Schroedinger, and Dirac equations and the equations of Maxwell. Special consideration is given to the process of abstracting the most important interrelations from physical phenomena and representing them in the form of differential equations. The technique is introduced by way of a one-dimensional problem which is thoroughly investigated before the reader is exposed to the more difficult cases of wave-motion in elastic media, the motion of fluids, and the electromagnetic field. The equations of quantum mechanics are discussed in detail and the connexions between various phenomena in classical and quantum physics are outlined. The third chapter indicates the relation between the equations of field theory and the variational principle of Hamilton.

The following six chapters are devoted to the strategy of analysis. Beginning with an account of function theory and transformation calculus they proceed to an elaborate study of the differential equations previously introduced and the analytical properties of their solutions. The emphasis of these chapters is on the determination of the particular combination of solutions, from all possible solutions, which satisfy the boundary conditions of a specific problem. An exhaustive treatment is given of the techniques of separable co-ordinates, expansion in eigenfunctions, and Green's function. The topic of mathematical representation concludes with a discussion of the significance of the integral equation formulation of boundary value problems and a survey of approximate methods.

The remaining four chapters deal with the application of the more advanced techniques to specific problems of modern theoretical physics. The authors' primary concern is that of analytical method; the reader is assumed to possess a reasonable knowledge of the relevant physics.

The work has been executed on a lavish scale and considerable care has been given to details of presentation. Each chapter concludes with a table summarizing the salient results, a group of problems to be worked by the reader, and a list of references. The diagrams employed to illustrate three-dimensional phenomena are presented as stereoscopic pairs. If these are viewed with the eyes relaxed at infinity, they are seen in relief without the need for a stereoscope. A selection of tables for use in numerical computation is given in the appendix. The appearance and quality of the books are of the high standard now expected of the publishing house whence they come.

There can be little doubt that this work will quickly establish itself as a standard treatise on the methods of theoretical physics and become a necessary part of the equipment of those engaged in fundamental physical research.

S. R. DEARDS

Principles and Practice of Radar

By H. E. Penrose and R. S. H. Boulding. 795 pp., 500 figs. Royal 8vo. 4th Edition (revised). George Newnes Ltd. 1953. Price 50s.

IN this revised edition, the introductory chapters on the basic principles of radio practice have been summarized, and now form a single chapter. The space saved has been used to amplify those parts of the book which experience has shown to be of most practical use to students, operators and technicians. The section dealing with actual equipments has been enlarged. In addition to the B.T.H., Sperry, Kelvin-Hughes and Liverpool Harbour radars, sections on the Decca, Cossor and Marconi radars are now included, together with a section on airfield control radar. A new chapter on radar test gear has been added.

Television Antennas and Converters

By Allan Lytel. 118 pp., 65 figs. Demy 8vo. John F. Ryder, Inc., New York. 1953. Price $3.50.

THE purpose of this book is to explain in simple terms the function and operation of U.H.F. conversion systems in America. Emphasis is placed not only on the convertor systems but also on the antenna structures and transmission line systems. No involved mathematics have been included and every effort has been made to use circuits and descriptions that are useful and practical.

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BOOK REVIEWS (Continued)

Probability and Information Theory, with Applications to Radar

By P. M. Woodward. 128 pp., 20 figs. Post 8vo. McGraw-Hill Book Co., Inc., New York. Pergammon Press Ltd., London. 1953. Price 21s.

THE first three chapters of this monograph deal respectively with Probability Theory, Waveform Analysis and Information Theory, and give remarkably lucid introductions to these subjects. Each of these chapters might well be read for its own sake, though intended as an introduction to the later parts of the book.

Chapter IV applies statistical methods to the problem of reception, and is applicable both to radar and communication. The function of an ideal receiver is to form from the received signal the distribution of probabilities of the set of possible messages, and this process is analyzed. Results are derived which have a bearing on the design of receivers for amplitude modulation. A valuable feature of the treatment is that it takes account of the effect of unknown signal parameters, which would arise, for instance, if the signal underwent an unknown attenuation due to fading. The effect on reception of a noise level differing from that for which the system was designed is also briefly considered.

In Chapter V are derived the characteristics of a radar receiver giving the greatest possible amount of information regarding range and presence or absence of a target. In Chapter VI radar information is analyzed and expressions derived for the information gain of a radar system. Chapter VII deals mainly with the problem of resolving two targets which differ only slightly in range or velocity. Resolution depends on the waveform of the transmitted signal, and the theory Chapter VII might reasonably be expected to yield an expression for an optimum waveform. No such expression has been derived, however, for the problem is a complex one.

Apart from its value to designers of radar systems, the book is of more general interest because it describes an application of Information Theory to observation, as distinct from communication. The idea of information as a measurable quantity lies behind the reasoning in the three chapters dealing with radar, even though it is only in one section of Chapter VI that a measure of amount of information appears as a term in the equations. Elsewhere in these chapters the ideas of Information Theory are used in ensuring that signals are subjected only to information-preserving transformations. It seems likely that Information Theory will prove applicable to other systems of observation and measurement.

The book is mathematical in nature, with 375 equations in 125 pages, but it is remarkably lucid and readable. An understanding of differentiation, integration and some properties of complex numbers is required of the reader. Taylor's Theorem is used on pages 18 and 103, Undetermined Multipliers on pages 25 and 54, and Bessel Functions on pages 77 and 97, but no knowledge of the properties of the last named is needed to follow the reasoning.

A. M. ANDREW.

Soft Magnetic Materials for Telecommunications

Edited by C. E. Richards and A. C. Lynch. 346 pp., 60 figs. Demy 8vo. Pergamon Press. 1953. Price 63s.

THE appearance of this book is somewhat deceptive; it is not, as its format and title might suggest, a general reference book on soft magnetic materials, but contains the papers presented at the Conference on Soft Magnetic Materials held at the Post Office Research Station, Dollis Hill, in April, 1952. Most of the thirty-five papers included are specialist papers and together cover a wide range of subject matter, but the Conference is not distinguished by any paper making a major contribution to the theory or practice of ferromagnetism. As only a few of the papers are likely to be of permanent interest to an individual, the book is not likely to be purchased privately but is mainly for reference libraries.

The problem of classifying the material is very difficult; the publisher's courageously attempt the task by saying "Several papers deal with each of the following topics:—Magnetic after-effects and losses in alternating fields; various observed types of non-linearity, especially in ferrites; use of X-rays in studying the crystal structure of powder cores and grain oriented alloys. Study of surface layers on high-permeability materials; study of rectangular loop materials and their applications; performance at high frequencies of ferrite material."

Some of the papers of more general interest to the engineer include one by Greig and Shurmer on iron losses with two superimposed excitation frequencies; a paper by De Barr and Frost-Smith on instrument transductors, in which they suggest a figure of merit for cores, taking into account permeability, sharpness of saturation and linearity, and also indicate the value of employing a composite core constructed of two different magnetic materials; and Randall and Scholefield's paper on the effect of cold reduction and heat treatment on 50/50 and 80/20 nickel irons. McFarlane and Mole's paper on the properties and applications of silicon-irons contains much useful information, but most of it is readily available elsewhere. The paper by Bates, Davies and Harper deals with the measurement of A.C. iron losses using a calorimetric method—a method likely to be more widely employed in future as a result of the work of this school, now that a way is shown of avoiding most of the difficulties previously associated with calorimetric measurements.

The book also contains a paper by Kersten, who presents a modification and extension of his theory of initial permeability, and a short paper by Néel on the reduction in permeability at high frequencies due to the domain structure.

L. R. BLAKE

Technique de la Television

By A. V. J. Martin. 296 pp., 380 figs. Demy 8vo. Editions Radio, Paris. 1953. Price Fr.1080.

THIS book should prove of value to all those interested in the working and development of television. Written by the Editor of *Television*, the theory and technique of the subject are discussed, together with future plans for the expansion of the French television network.

Microwave Lenses

By J. Brown. 125 pp., 55 figs. Crown 8vo. Methuen & Co. Ltd. 1953. Price 12s. 6d.

THIS recent addition to the list of Methuen's Monographs on Physical Subjects presents a concise survey of a specialized branch of Radio Engineering which has in the last few years been the subject of much interest and controversy on both sides of the Atlantic. This book is a well balanced critical account and will do much to stimulate the interest and may settle some of the controversy.

The author has appreciated that many of his readers will need to revise their knowledge of physical optics before being able to appreciate the finer points of lens design, and the first three chapters cover the essential principles upon which the behaviour of the dielectrics used in lenses, and the design of such lenses, depend. Chapters IV and V deal with artificial dielectrics of the "delay" and "phase advance" types, and, as well as giving a very readable introduction to the theory of the mechanism of such dielectrics, provide a useful amount of design information in the form of families of curves connecting geometrical parameters with refractive indices. The chapter on "Wide Angle Scanning" illustrates an application in which the advantages of lenses are exploited to the full, and the more specialized chapters covering such topics as the optics of non-homogeneous media and configuration focusing may well point to the direction in which future developments will lie.

The final chapter on "Lens Aerials" suggests approaches to design procedures and also amounts to a very fair summing up of the pros and cons of lenses compared with mirrors. Such an assessment of relative advantages is inevitably controversial, and some engineers may well consider that recent advances in structural techniques have swung the balance further in favour of mirrors for some applications.

The book is very clear and, although thorough, should not strain the mathematical resources of the average reader. A very comprehensive bibliography is appended.

S. S. D. JONES.

LETTERS TO THE EDITOR

(We do not hold ourselves responsible for the opinions of our correspondents)

Transistor Symbol

DEAR SIR,—One of the difficulties of understanding and designing transistor circuits is that the symbol usually employed does not present a visual representation of its electrical properties. In particular, the collector appears to be firmly tied to the base electrode, so that it is hard to imagine that a potential difference could exist between them.

Suggested transistor symbol

If the symbol could suggest not only that a potential difference could exist between the collector and base electrode, but that it could be influenced in some way by the emitter, the symbol could serve as a working diagram for the action of a transistor. Such a symbol might be drawn as shown. In the drawing, the arrow is the emitter which retains the feature of suggesting the rectifier action between it and the electrode possessed by the existing symbol. The wire ending in a blob is the collector.

Yours faithfully,
L. MOLYNEUX,
Newcastle-upon-Tyne.

High Frequency Effects in Germanium Diodes

DEAR SIR,—In connexion with the article by Messrs. Jones and Brodribb in your January issue I would like to report another anomalous effect.

It was observed that a proportion of production television receivers showed on test a "tailing" effect—any large black area being followed by a long white or dark "tail"—and it was found that this could be corrected by changing the crystal used as vision detector. The matter was investigated by applying a square wave at various frequencies to the faulty crystals, and results like those in Fig. 1 were obtained: the instantaneous back resistance R_b is seen to be higher or lower (depending on the input) than the normal value for a period after the voltage is applied. In the typical case shown, the peak R_b occurs after 10-30μsec, but other tests with longer pulses have shown analogous effects with time constants up to a millisecond or more. The effect is not dependent upon the application of a positive voltage at some point in the cycle. The phenomena may also be demonstrated by displaying the dynamic V-I characteristic upon a C.R., as illustrated in Fig. 2.

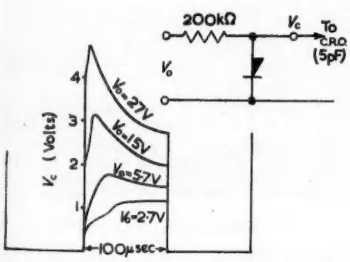


Fig. 1. Voltage V across a "tailing" crystal (T_{10}) for four values of input V_O (on 100μsec pulse

Crystals showing these effects all showed a rather low R_b (order of 10kohms) and were found to exhibit a hysteresis effect in their D.C. characteristic: for example, the current passing with 1V applied in the backward direction became two or three times greater after a higher voltage (say 10V) had been momentarily applied, the crystal returning slowly (in a matter of minutes) to its original condition.

The effect reported here does not seem to have any direct connexion with that considered by Messrs. Jones and Brodribb (which we also have observed) nor with the similar high speed effects, with time constant less than 0·1μsec, reported by several other writers (e.g. WALTZ., *Proc. Inst. Rad. Eng.*, November, 1952).

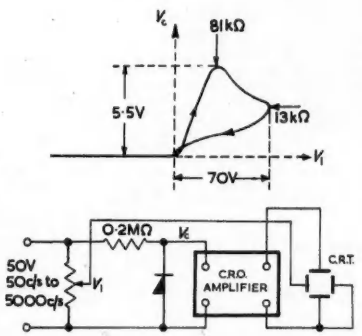


Fig. 2. Dynamic characteristic for a "tailing" crystal (at 50c/s)

Yours faithfully,
M. V. CALLENDAR,
E. K. Cole Ltd.
Southend-on-Sea.

The Equivalent Q of R.C. Networks

DEAR SIR,—You have been offered several different numerical values for the Q of the *RC* network. These discrepancies do not arise from any difficulty inherent in the *RC* network. For the in-phase condition, it is not contested that the rate of change of phase with relative frequency is given by $A = -1{\cdot}3$. The difficulty arises in the *LRC* circuit, when the attempt is made to redefine its Q in terms of its A.

The only reason for introducing the *LRC* circuit is to provide a model, which is intended to illustrate the meaning that is to be attached to Q. The choice of *LRC* circuit would have given simpler results. If the parallel *LRC* circuit is regarded as of more practical interest, a simpler result can be obtained by disregarding the total applied voltage, and concentrating attention on the relationship of the voltage across the inductor to the total applied current. (This voltage is measurable as the secondary voltage of a transformer, of which the primary is the *LR* of the *LRC* circuit). It is then found that $A = -2Q$ and that this equation applies for all values of Q. If Q is appropriately defined, the formula also applies if there is loss in the capacitor as well as in the inductor.

The care needed in specifying the exact points between which the voltage must be measured arises because A is a property, not of the circuit itself, but of the particular output that is taken from it. On the other hand, Q can be defined in such a way that it is a circuit property, independent of the particular output that is measured. The definition will apply to many *RC* circuits, but not to ladder networks of three stages or more. The performance of such networks is appropriately specified by A, which is a valuable parameter in its own right.

Yours faithfully,
DAVID MORRIS,
Department of Electrical Engineering.
University College of North Wales.

Setting a Trigger Circuit by a Contact

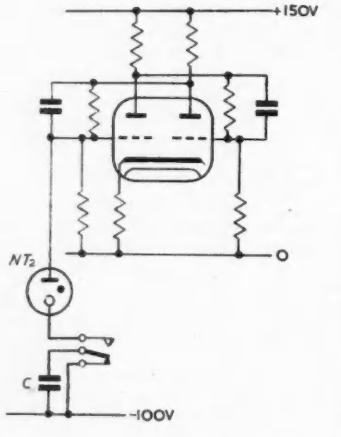
DEAR SIR,—It is frequently necessary in computors and other applications to set a trigger circuit in its appropriate "0" or "1" state by means of a remote mechanically or electrically operated contact. As it may be necessary to repeat this a large number of times, it is desirable to devise a simple circuit to avoid adding a considerable number of valves to the equipment.

At first sight this might appear to be a fairly straightforward problem, but two factors make it difficult in practice. Firstly, it is not possible to connect a long length of wire, which it may be necessary to bind in a cable form, to the grid or anode of a trigger, without upsetting its performance due to the

capacitance of the wire to its surroundings. Secondly, a contact rarely makes its connexion cleanly, but usually with a series of short makes and breaks, before coming to rest in the fully made condition. The effect of these short impulses when applied through a small capacitor to the grid or anode of a trigger circuit is occasionally to pulse it on or off several times so that it comes to rest in a random condition.

A simple circuit which has been found to offer a satisfactory solution is shown below. A conventional trigger circuit has one electrode of a small Type NT2 neon diode connected to its grid by short wiring. The other electrode of the neon diode is taken through the cable forms to the make spring of a changeover contact, the centre spring of which is taken through capacitor C to −100 volts. In the non-operated condition the back contact short circuits the capacitor.

When the contact is operated, the discharged *C* is connected in series with the neon tube to the grid of the trigger. As



the voltage applied across the neon tube is greater than its striking voltage it ionizes and a short pulse of current flows through it to charge the capacitor. As the capacitor charges, its voltage rises until it reaches a point where the voltage across the neon is insufficient to maintain the discharge, and the neon de-ionizes. The reduction of the voltage across the neon is also assisted by the falling in voltage of the trigger grid when it is operated. After the neon tube has de-ionized, the trigger circuit is isolated from the remainder of the circuit except for the capacitance of the neon tube electrodes, until the charge on *C* leaks away, which is negligibly long in comparison with the speed of operation of the machine. The value of the capacitor *C* will depend on the wiring capacities and the de-ionization time required. With a 0·001μf capacitor the neon tube was found to de-ionize in about 1msec.

Yours faithfully,

R. TOWNSEND,
Electronic Laboratory
The British Tabulating
Machine Co. Ltd.

Meetings this Month

THE BRITISH INSTITUTION OF RADIO ENGINEERS

Date: April 21. Time: 6.30 p.m.
Held at: The London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1.
Lecture: Crystal Valves in Radio and Electronics.
By: B. R. A. Bettridge.

North Eastern Section

Date: April 14. Time: 6 p.m.
Held at: Neville Hall, Westgate Road, Newcastle-on-Tyne.
Lecture: Electroencephalography.
By: Alexander Kennedy and J. W. Osselton.

Merseyside Section

Date: April 1. Time: 7 p.m.
Held at: The Electricity Service Centre, Whitechapel, Liverpool, 1.
Lecture: Logic, Algebra and Relays.
By: E. Williams.

West Midlands Section

Date: April 27. Time: 7.15 p.m.
Held at: The Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton.
Lecture: Radio Telephone Equipment.
By: T. C. Howell.

THE BRITISH SOUND RECORDING ASSOCIATION

Date: April 9. Time: 7 p.m.
Held at: The Royal Society of Arts, John Adam Street, London, W.C.2.
Lecture: The Design of Tone Correction Circuits.
By: E. W. Berth-Jones and H. J. Houlgate.

THE INSTITUTE OF PHYSICS

Date: April 1. Time: 10 a.m.—12.30 p.m. 2 p.m.—5 p.m.
Held at: The Cavendish Laboratory, Cambridge.
Series of Lectures: X-ray Analysis.
By: G. E. Bacon, J. A. F. Smith, H. Lipson, W. Cochran, A. F. Douglas, F. Fowweather, P. J. Weakley, D. W. J. Cruickshank.
Date: April 2. Time: 10.15 a.m.—12.30 p.m. 2 p.m.—4 p.m.
Continuation of lectures on above subject.
By: J. M. Robertson, H. P. Stadler, P. J. Black, B. H. Wiebenga and A. F. Wells.

THE INSTITUTION OF ELECTRICAL ENGINEERS

All London meetings, unless otherwise stated, will be held at the Institution, commencing at 5.30 p.m.
Date: April 1.
Lecture: The Possibilities of a Cross-Channel Power Link.
By: D. P. Sayers, M. E. Laborde and F. J. Lane.
Date: April 29.
The 45th Kelvin Lecture: The Physics of the Ionosphere.
By: J. A. Ratcliffe.

Radio Section

Date: April 5.
Discussion: Technical Problems involved in Receiving Alternative Television Programmes.

Measurements Section

Date: April 6.
Lectures: Determination of the Static and Dynamic Elastic Properties of Resilient Materials.
By: R. S. Jackson, A. J. King and C. R. Maguire.
A Method of Using Microwaves for Measuring Small Displacements and a Torque Meter using this Principle.
By: N. C. de V. Enslin. (To be read by Prof. R. Guelke.)
Magnetic Measurement of Mechanical Hardness.
By: D. Hadfield.

Radio and Measurements Sections

Date: April 7.
A Group of Papers on Recent Work on Transistors: A Versatile Transistor Circuit.
By: E. H. Cooke-Yarborough.
The Measurement of the Small-Signal Characteristics of Transistors.
By: E. H. Cooke-Yarborough, C. D. Florida and J. H. Stephen.
A Bridge for Measuring the A.C. Parameters of Type "A" Transistors.
By: A. R. Boothroyd and L. K. Datta.
The Transistor as a Regenerative Amplifier with some Application to Computing Circuits.
By: G. B. B. Chaplin.

Mersey and North Wales Centre

Date: April 5. Time: 6.30 p.m.
Held at: The Liverpool Royal Institution, Colquitt Street, Liverpool.
Annual General Meeting and Lecture: Technical Arrangements for the Sound and Television Broadcasts of the Coronation on June 2 1953.
By: W. S. Procter, M. J. L. Pulling and F. Williams.

North-Eastern Centre

Date: April 12. Time: 6.15 p.m.
Held at: The Station Hotel, Newcastle-on-Tyne.
Annual General Meeting and General Conversazione.

North Midland Centre

Date: April 1. Time: 7.15 p.m.
Held at: The Yorkshire Electricity Board, Ferensway, Hull.
Lecture: Voltage Transformers and Current Transformers associated with Switchgear.
By: W. Gray and A. Wright.
Date: April 12. Time: 7 p.m.
Held at: The Town Hall, Leeds.
Faraday Lecture: Electro-Heat and Prosperity.
By: O. W. Humphreys.

South Midland Centre

Date: April 5. Time: 6 p.m.
Held at: The James Watt Memorial Institute, Great Charles Street, Birmingham.
Lecture: The Development and Application of Nuclear Reactors.
By: R. V. Moore.

South Midland Radio Group

Date: April 26. Time: 6 p.m.
Held at: The James Watt Memorial Institute, Birmingham.
Lecture: The Theory and Application of Transistors.
By: F. F. Roberts and H. G. Bassett.

South Midland Supply and Utilization Group

Date: April 5. Time: 6 p.m.
Held at: The Imperial Hotel, Birmingham.
Lecture: The Electrolytic Analogue in the Design of High-Voltage Power Transformers.
By: D. McDonald.

THE INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Date: April 14. Time: 5 p.m.
Held at: The Conference Room, 4th Floor, Waterloo Bridge House, London, S.E.1.
Lecture: Television Receiving Aerials.
By: G. L. Stephens.

THE TELEVISION SOCIETY

Date: April 13 and 15. Time: 7 p.m.
Held at: The University of London Institute of Education, Senate House, London, W.C.1.
Lecture: Colour Television.
By: G. G. Couriet.

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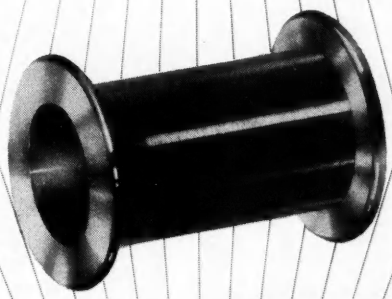

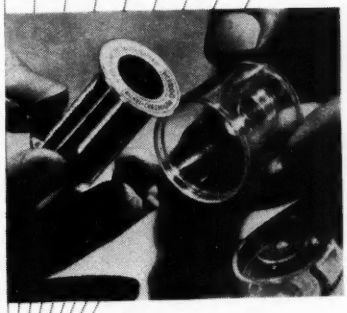

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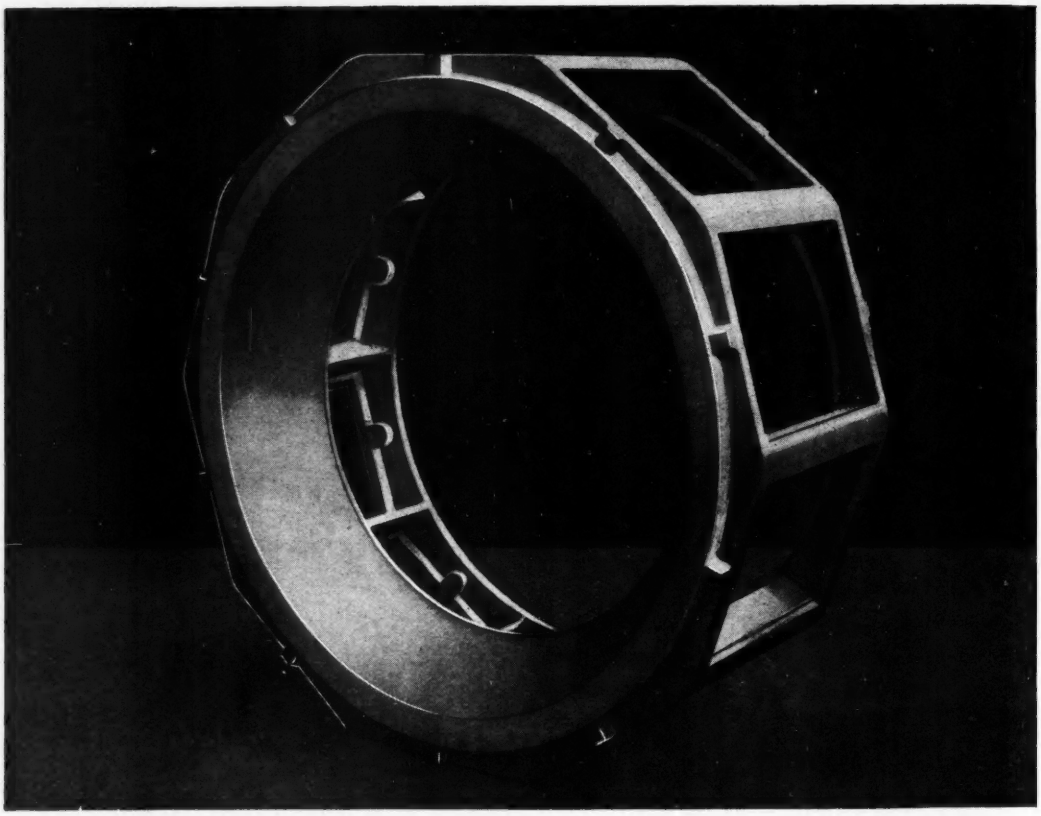

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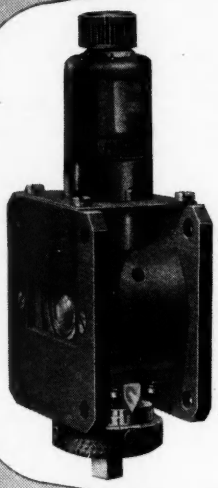

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TTR.31MR and TTR.31MC Tunable medium Q T.R. Cells for use with standard American waveguide (TTR.31MR) or ¾" diameter circular waveguide (TTR.31MC)
Frequency Range : 9100-9900 Mc/s
Band Width : 25 Mc/s
Handling Power : 50 kW. peak

Full details of these and other T.R. Cells from our range will be supplied on request.

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at the R.E.C.M.F. EXHIBITION
APRIL 6th to 8th, 1954

'PENTLAND' SERIES RESIN CAST COMPONENTS

The Ferranti 'Pentland' series of components includes Power Transformers and Chokes, Signal and Pulse Transformers and Delay Networks.

These units are cast in a solid block of synthetic resin which replaces the oil-filled container previously considered essential for high quality components and below are listed some of the notable advantages conferred by this technique :

Extreme robustness combined with minimum weight and volume.

Complete hermetic sealing.

Fire risk greatly reduced.

Reliable operation through a wide range of ambient temperatures and climatic conditions.

'Pentland' series components are designed to customers' specification and full details will be supplied on request.

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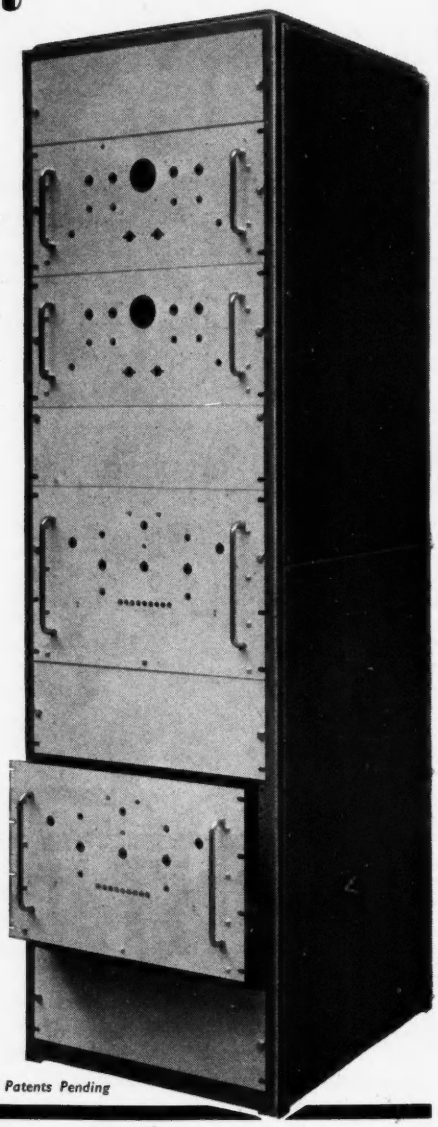
FERRANTI LTD FERRY ROAD EDINBURGH 5

Electronic Instrument Cabinets, Racks and Cases

Your delicate and expensive Electronic Equipment deserves worthy housing. H. & H. Cabinets and Racks add, to unique design and precision craftsmanship, the crowning merit of superb finish. Specialists in the production of precision sheet metal work, for many years, we are admirably equipped to provide to your own specification Cabinets of a high standard of craftsmanship throughout at reasonable prices.

Our Design and Development Staff is always at your disposal. May we serve you ?



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Overall height 68½"
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" depth 24"

We also manufacture precision components to users' designs : All types of Valve Screens, Coil Cans, Chassis, Panels, Condenser Mountings, Valve Mountings, Loud Speaker Chassis, and pressings and sub-assemblies in any metal.

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STAND No. 117

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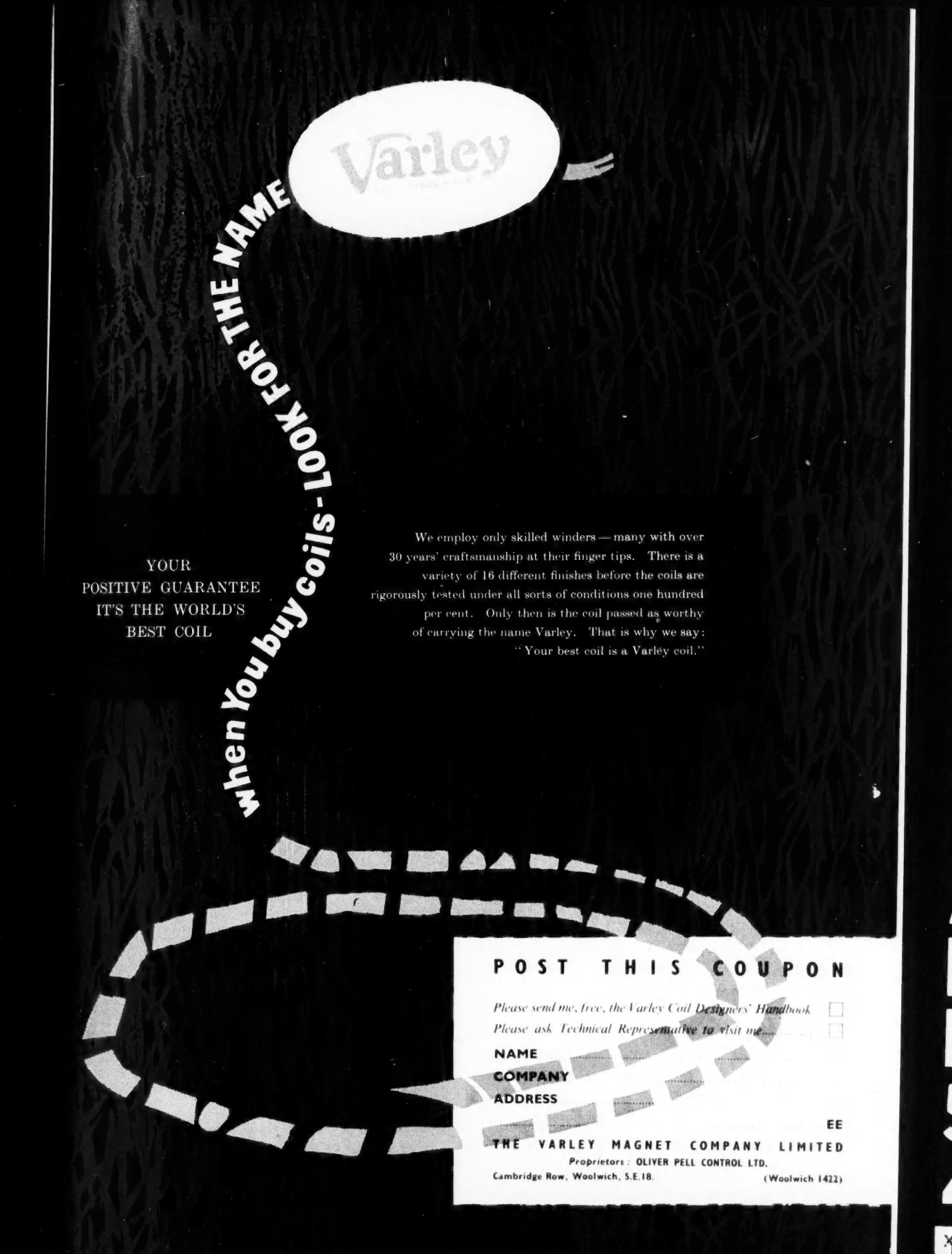
6 – 7 – 8th April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machine screw and bolts
Manufactured in a range of sizes from 8 B.A. t
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Extreme accuracy of effective diameter, pitch an
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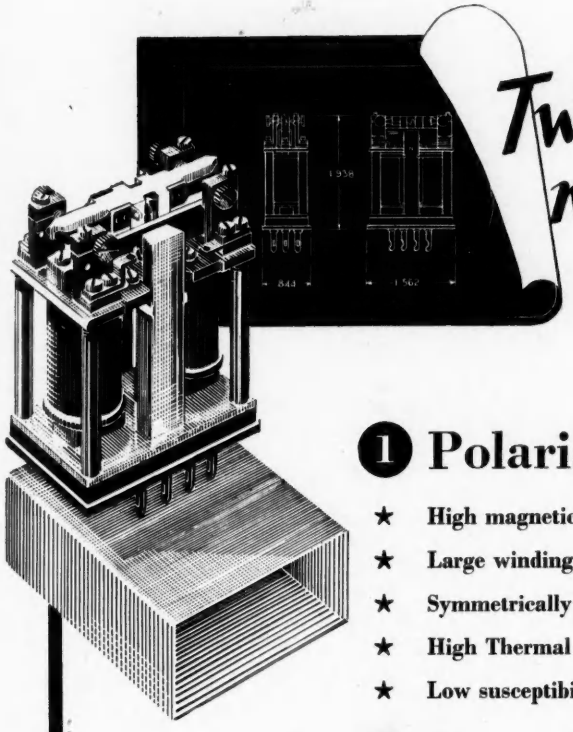
Two NEW miniature Relays

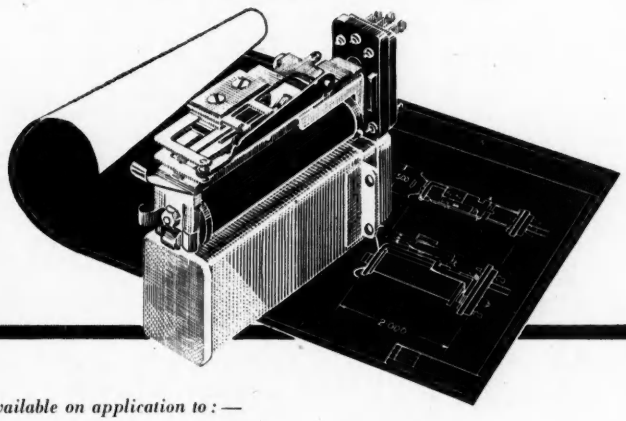


1 Polarised Relay

- ★ High magnetic sensitivity
- ★ Large winding space · High copper efficiency
- ★ Symmetrically balanced movement
- ★ High Thermal and Shock stability
- ★ Low susceptibility to magnetic interference

2 Type 1A Relay

- ★ Exceptionally high sensitivity
- ★ Balanced movement
- ★ High Thermal and Shock stability
- ★ Hermetically sealed



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Catalogue available on application to : —

Head Office : 22 LINCOLN'S INN FIELDS LONDON WC2 *Tel: HOL. 6936*

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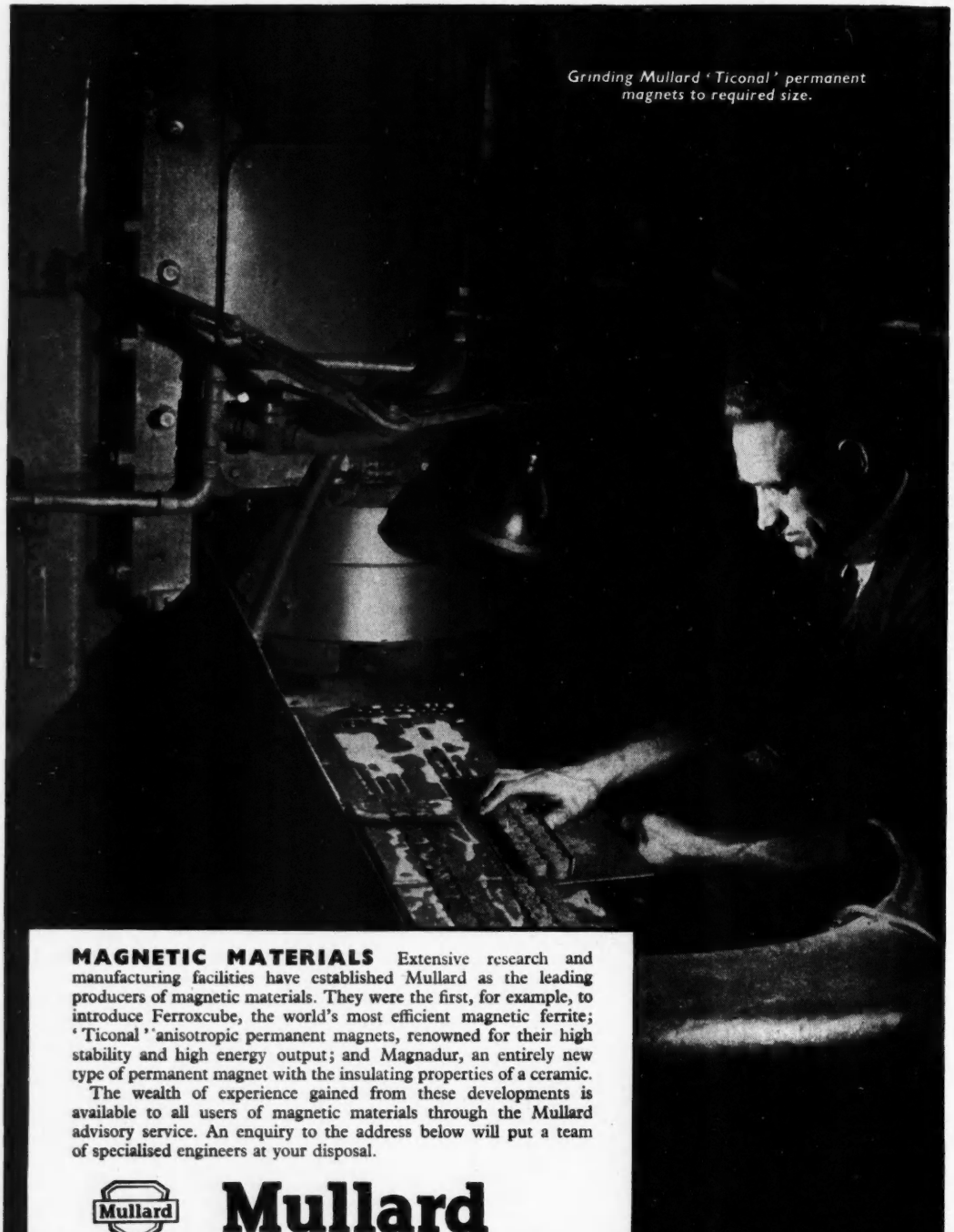


Grinding Mullard 'Ticonal' permanent magnets to required size.

MAGNETIC MATERIALS Extensive research and manufacturing facilities have established Mullard as the leading producers of magnetic materials. They were the first, for example, to introduce Ferroxcube, the world's most efficient magnetic ferrite; 'Ticonal' anisotropic permanent magnets, renowned for their high stability and high energy output; and Magnadur, an entirely new type of permanent magnet with the insulating properties of a ceramic.

The wealth of experience gained from these developments is available to all users of magnetic materials through the Mullard advisory service. An enquiry to the address below will put a team of specialised engineers at your disposal.

Mullard

Mullard

'TICONAL' PERMANENT MAGNETS · MAGNADUR (Formerly Ferroxdure) PERMANENT MAGNETS · FERROXCUBE MAGNETIC CORE MATERIAL

MULLARD LTD., COMPONENT DIVISION, CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2.

Photograph by courtesy of Handley Page Ltd.

PRE- with GOODMANS VIBRATORS

The flight characteristics of a newly designed aeroplane are the subject of lengthy calculations before the first prototype is built. Whilst the mathematical calculations are themselves accurate, they are based, as in all design work, on several assumptions which have to be verified by a series of pre-flight tests.

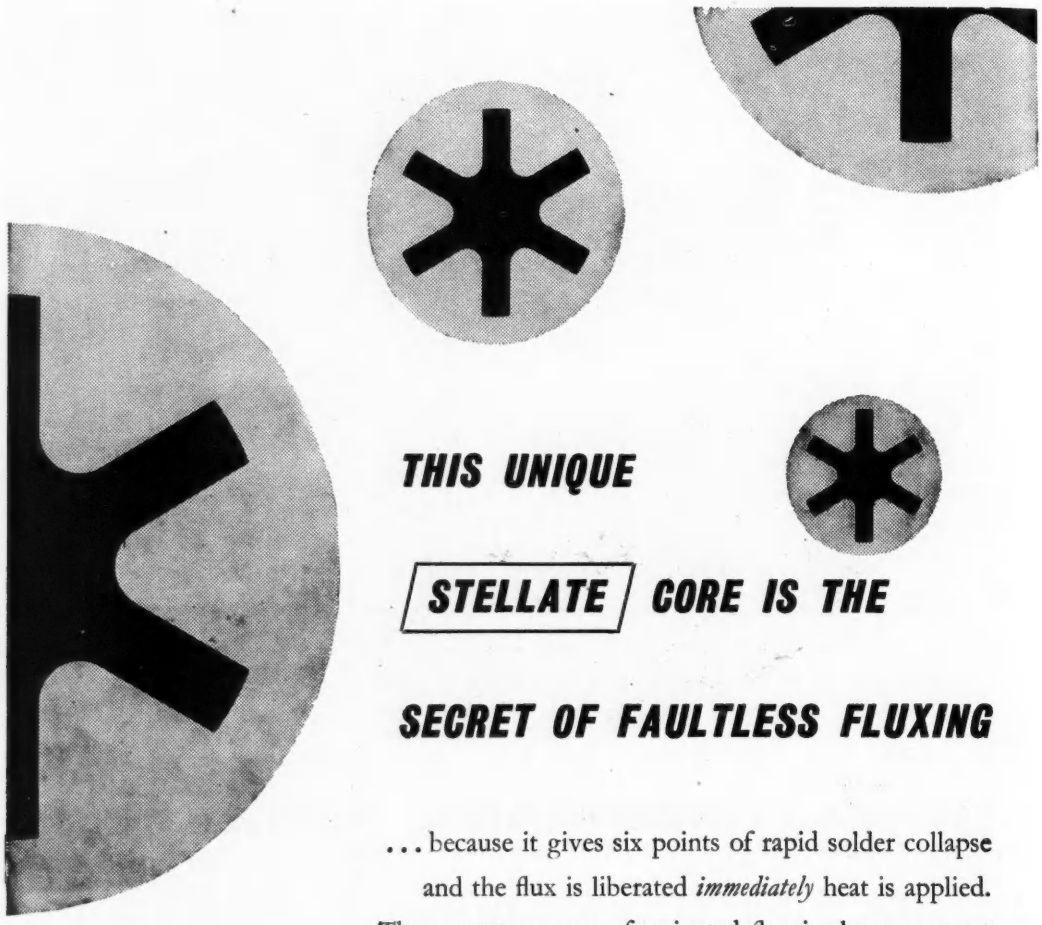
One of these essential investigations is the Ground Resonance test, the purpose of which is to determine the various complex modes of vibration of the airframe structure. The frequency of the mode and the dynamic response at remote parts of the aircraft must be accurately determined. The information obtained together with the aerodynamic derivatives is used in predicting the critical ' flutter ' speed of the aircraft. The illustration shows one of the two Goodmans Model 8/600 Vibration Generators which were used to excite the Handley Page " Victor " for this very important test.

For wide frequency range vibration testing and dynamic response investigations, Goodmans Vibration Generators are an obvious choice. These units require no field excitation and provide a faithful reproduction of the input wave form. Industrial applications of controlled vibration are continually increasing ; maybe it can serve you—in which case our unique experience is at your service.

The range includes models from the 8/600 *shown, developing a force of* ± 300 *lb., to the midget model, with a force of* ± 2 *lb., for optical cell research and hairspring torque testing, etc.*

Just another of the wide applications of Goodmans Vibration Generators. Full technical data available from Vibration Division E.

GOODMANS INDUSTRIES LIMITED, Axiom Works · Wembley · Middx · Wembley 1200 (8 lines)
GD



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STELLATE CORE IS THE

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. . . because it gives six points of rapid solder collapse and the flux is liberated *immediately* heat is applied. The correct amount of activated flux is always present in Superspeed, thus eliminating dry or H.R. joints. The stellate core is featured only in the Enthoven range of cored solders which ensures perfect soldering.

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ACTIVATED ROSIN CORED SOLDER

for all Radio, T.V. electronic and telecommunication soldering. Complies with M.O.S. Specification DTD. 599 and is approved by the A.I.D., G.P.O. and R.C.S.C. Superspeed is available in a wide range of alloys and gauges. Samples together with comprehensive literature gladly sent on request. Technical advisers are available for consultation.

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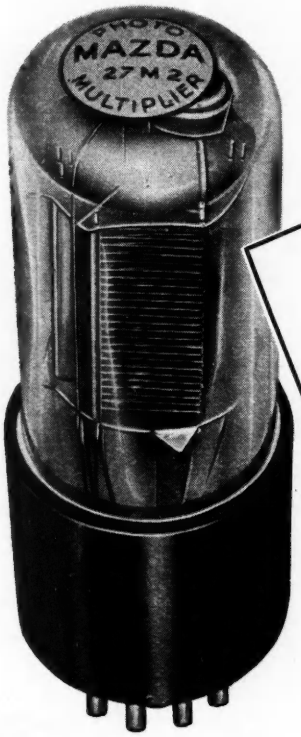

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to give prompt deliveries of

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MAZDA

*27M1 & 27M2 HIGH-VACUUM PHOTO MULTIPLIERS

Complete details and prices of Ediswan Mazda photo-multipliers will be supplied on request.

*These valves are plug-in replacements for the American type 931A.

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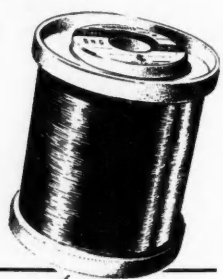
RV133

Send for Yours To-day . . .

Connollys have produced five handy "slide rule" tables which give, at a glance, considerable data not normally available in ready form, concerning winding wires as follows:

Enamel Normal	**"Oleo Resinous"**	**to B.S.S. 156/1951**
Conymel F	**"Vinyl Acetal"**	**to B.S.S. 1844/1952**
Conymel M	" "	" " "
Conymel T	" "	" " "
Conymel X	" "	" " "

We shall be pleased to mail you one or more sets, if you will kindly write us on your business letterheading.



CONNOLLYS *Winding Wires*

The largest manufacturers of fine enamelled wires in the world

CONNOLLYS (BLACKLEY) LIMITED., Kirkby Trading Estate, Near Liverpool

Telephone: SIMonswood 2664. Telegrams: "SYLLONOC, LIVERPOOL"

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The New Pack Set type 46
B.C.C. VHF Communications Equipment stands alone in its class. Unequalled performance and reliability is combined with ease of maintenance and simplicity of operation.
B.C.C. sets the standard for reliability and efficiency.

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BRITISH COMMUNICATIONS CORPORATION LIMITED

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Telephone : Wembley 1212

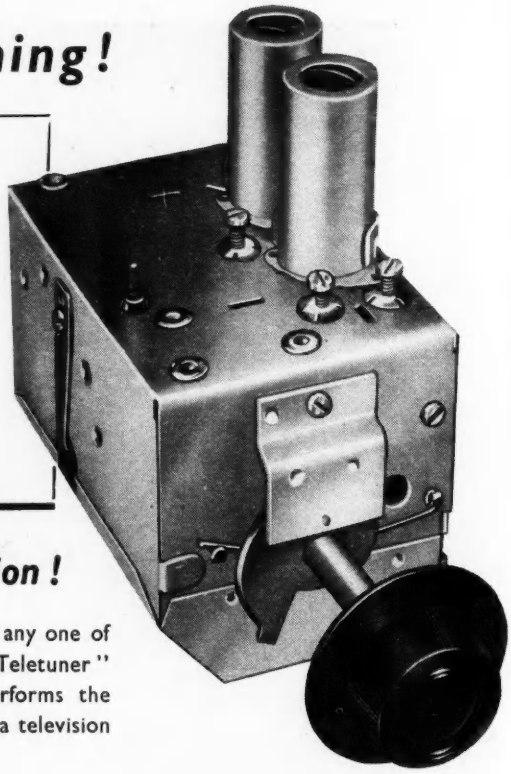
Multi-channel tuning!

Cyldon

"TELETUNER"

(TRADE MARK)

Type TV.12



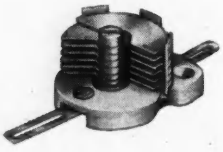
Instant, single-knob selection!

Select a frequency in the 50-220 Mc/s range—select any one of twelve in fact—and this new Cyldon Multi-channel "Teletuner" will handle it. This compact two valve unit performs the functions of R.F. amplifier and frequency changer in a television receiver. ***Write for Folder TV 1953.***

FOUR NEW TRIMMERS

by the Makers of "Cyldon" Trimmers and Variable Capacitors

No. 26. Mica Compression Trimmer.



No. 28. Air Spaced Trimmer.

No. 29. Glass Trimmer.

No. 30. Ceramic Trimmer.

Full details and specifications available on application

R.E.C.M.F. EXHIBITION
April 6—8
See us on Stand No.
53

SYDNEY. S. BIRD & SONS. LTD.

Contractors to Ministry of Supply, Post Office, and other H.M. Government Depts.

CAMBRIDGE ARTERIAL RD., ENFIELD, MIDDX.

Telephone: Enfield 2071-2.
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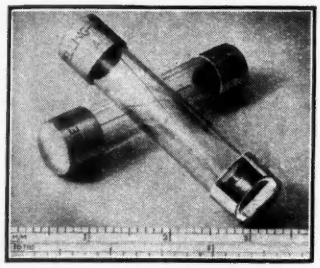
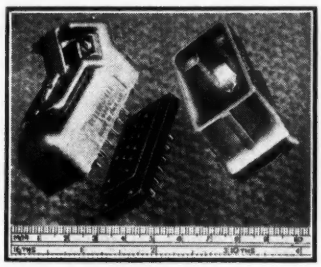
The "Belling-Lee" Page

Guide to the R.E.C.M.F. Exhibition

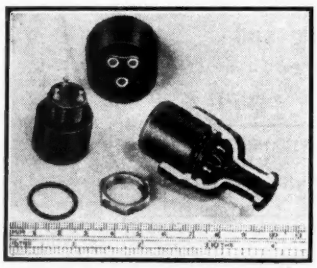
Stand No. 55



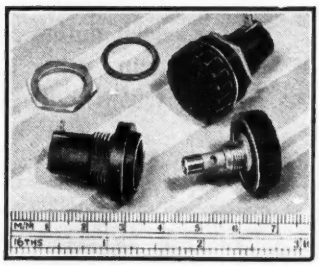


New and established lines which have been redesigned, feature prominently in the 1954 range of "Belling-Lee" components and accessories for the Electronic, Radio, and Electrical Industries.

"Unitor" and "Screenector" contacts are now hard gold plated and this finish will be added to other lines as appropriate.

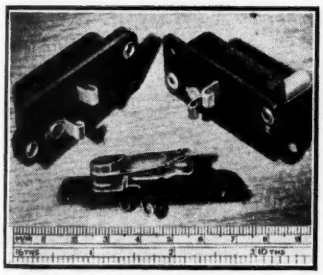


Many ratings of the well-known general-purpose instrument fuselink, L.1055, are now manufactured by an entirely new technique which bonds caps, glass, and filament into one unit, caps being so securely held that they will not come off unless the glass is broken.



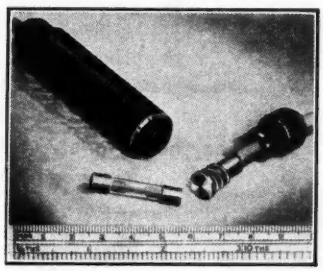
A new range of six fuseholders for Inter-Service use has been developed, and in addition to the existing types of sealed and neon indicating versions, forms a very comprehensive range.

Screened plugs and sockets with 4, 6 and 12-way assembles have been introduced. Assemblies are interchangeable with existing screened coaxial types.



Three and four mm. resilient sockets with square-faced nylon moulding are exhibited. Sockets can be mounted single or in groups.

The range of suppressors includes new types effective at television or broadcast frequencies.



For Further details please write for catalogue P.347/E.E.

BELLING & LEE LTD
GREAT CAMBRIDGE ROAD, ENFIELD, MIDDX., ENGLAND

Adjustable-Stabilized A.C. Voltage

WITH HARMONIC FILTER

This new Advance Constant Voltage Transformer is designed for use when an adjustable but closely regulated source of constant A.C. voltage is required. The "Volstat" is ideally suitable for the most exacting industrial applications as well as for general laboratory work.

It provides a portable, simple to handle instrument for such duties as instrument calibration and testing and many other operations involving factors that are sensitive to wave form and voltage.

Full technical details on Leaflet S19/M.

NET PRICE
(IN U.K.)
£29.10.0

- Output 'A' Variable 0-260 volts stabilised ± 1%.
- Output 'B' 230 volts ± 1%.
- Total Harmonic Distortion less than 5%.
- Maximum Output 170 watts.

See the complete ADVANCE Range on

STAND No. 11

R.E.C.M.F Exhibition

Advance 'VOLSTAT'

ADVANCE COMPONENTS LIMITED, BACK ROAD, SHERNHALL STREET, LONDON, E.17.

Telephone: LARkswood 4366/7/8 *Telegrams: Attenuate, Walt, London.*

ANNOUNCING

THREE NEW 'CINTEL' INSTRUMENTS

SIGNAL LEVEL METER

A dual purpose instrument for use as a general laboratory amplifier or sensitive valve voltmeter. Frequency range 20 c/s to 100 Kc/s. Gain 85 db.

INCREMENTAL INDUCTANCE BRIDGE

Designed to measure the inductance of iron cored chokes with d.c. flowing. Inductance range 0 to 1000H. Superimposed d.c. continuously variable from 0 to 1 amp.

AUTOMATIC FREQUENCY MONITOR (20 Mc/s.)

An extension of the well known range of 'Cintel' monitors, this new instrument will measure any frequency in the range 10 c/s to 20 Mc/s and present the answer in decimal notation on 8 panel mounted meters.

These new instruments together with the redesigned Flying-Spot Microscope MK II will be on view for the first time on STAND 38 at the PHYSICAL SOCIETY EXHIBITION. 8th-13th April Inc.

CINEMA-TELEVISION LIMITED

A Company within the J. Arthur Rank Organisation

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ALL-POWER

REGULATED POWER SUPPLIES

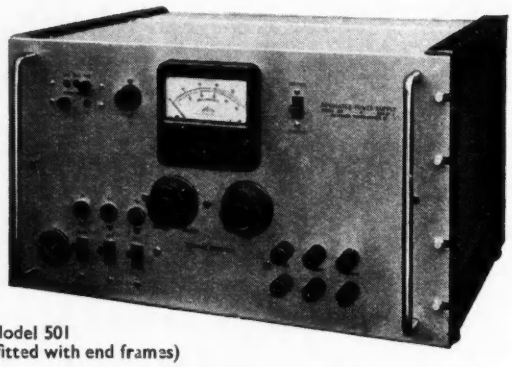
SERIES 500

4 NEW MODELS

RATED FOR 350mA OUTPUT

The four models detailed below are similar to the existing 500 series units and have the same overall physical dimensions.

AVAILABLE FOR PROMPT DELIVERY



Model 501
(fitted with end frames)

ABRIDGED DATA

(Further information on request)

	Data	Model 506	Model 507	Model 508	Model 509
Main+VE Stabilizer	Output	200-500V 350mA	200-500V 350mA	0-500V 350mA	0-500V 350mA
	Number of Ranges	2	2	4	4
	Voltage Stabilization	±0.02%	±0.002%	±0.1%	±0.002%
	Effective Output Resistance (max.)	0.2 Ω	0.02 Ω	0.5 Ω	0.02 Ω
	Output Ripple (rms. max.)	2mV	1mV	3mV	1mV
−VE Supply Stabilizer	Outputs	—	—	250V 25mA 0-250V 1mA	250V 25mA 0-250V 1mA
	Voltage Stabilization	—	—	±0.05%	±0.002%
	Output Resistance (max.)	—	—	1 Ω	0.01 Ω
	Output Ripple (rms. max.)	—	—	2mV	1mV
Unstabilized +VE H.T. Supply 350mA max.		470V 630V	470V 630V	320V 470V 630V	320V 470V 630V
Unstabilized A.C. Supply		6.3V 10A	6.3V 10A	6.3V 10A	6.3V 10A
Price		**£77**	**£98**	**£88**	**£106**

STANDARD UNITS. All models are supplied as standard for mounting in 19 in. racks and are fitted with fully protective covers.

EXTRAS. To convert from rack mounting to bench use the following extras are available :—

Polished hard-wood reinforced end frames ... ... **£1 15 0** per pair

Steel instrument case of new design ... ... **£4 10 0** each

PRICES. Prices are quoted net ex works and are subject to variation without notice.

ALL-POWER TRANSFORMERS LTD. . CHERTSEY ROAD, BYFLEET, SURREY

Tel. : BYFLEET 3224/5

TRANSDUCERS

for the measurement of STEADY, FLUCTUATING OR SURGE PRESSURES

(Gauge or Differential)

FOR STEADY OR SLOWLY FLUCTUATING PRESSURES

TYPE No. 548
0 — 5 p.s.i. to 0 — 4,000 p.s.i.
(as illustrated)

Comprising a Bourdon tube or bellows operating a precision potentiometer. These transducers produce a voltage output directly proportional to pressure.

FOR STEADY, FLUCTUATING OR SURGE PRESSURES

TYPE No. 522
0 — 25 p.s.i. to 0 — 2,500 p.s.i.

Pressure is applied to a diaphragm which is caused to change the inductance of an iron cored circuit. This change of inductance can then be used either to create out-of-balance in a bridge or to frequency modulate an oscillator.

TYPE No. 449 0 — 10 p.s.i. to 0 — 1,000 p.s.i.
TYPE No. 448 0 — 250 p.s.i. to 50,000 p.s.i.

Comprising a 4-arm strain gauge compensated bridge. These transducers produce a voltage output (m.V.) directly proportional to the applied pressure.

JLT GROUP

J. LANGHAM THOMPSON LTD.

BUSHEY HEATH · HERTS

Telephone: Bushey Heath 2411 · 'Grams & Cables: "Tommy Watford"

BRITISH MADE

BRIMAR

VALVES

More reliable than EVER!

Brimar's long experience in the manufacture of special quality TRUSTWORTHY valves is now being reflected throughout the entire Brimar range.

Improved production methods, new and better assembly jigs, tighter control on the composition of materials, and the closer supervision of vital processes have resulted in valves with more uniform characteristics, greater mechanical strength and a higher standard of reliability as shown in the 12AT7.

The 12AT7 is a very reliable frequency changer and is widely used in modern TV receivers, VHF and UHF communications equipment. It is also frequently employed in industrial equipment, computors, navigational aids and test equipment.

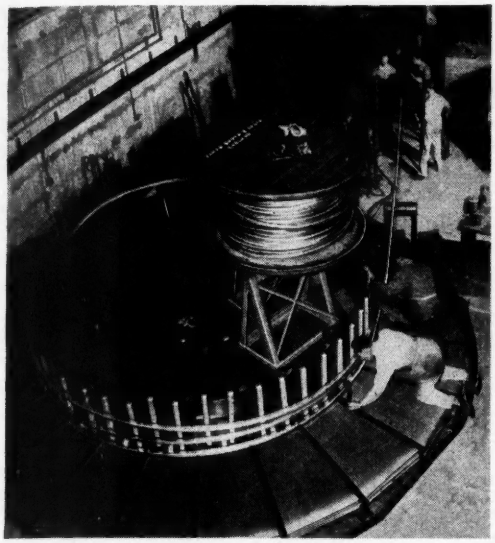
Use the BRIMAR 12AT7 with improved performance —at NO EXTRA COST

BRIMAR	MULLARD	MARCONI OSRAM	COSSOR EMITRON
12AT7	ECC81	B152 & B309	12AT7

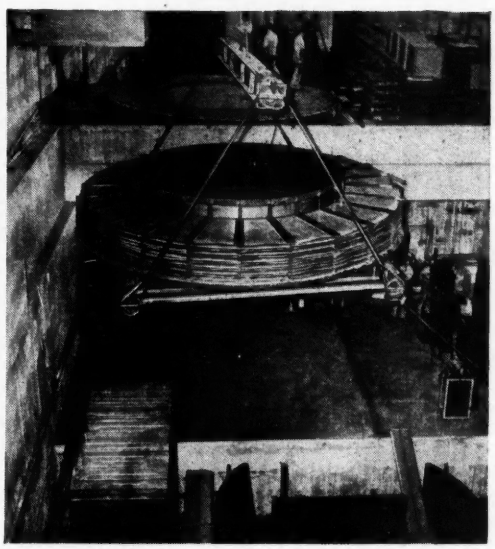
now is the time to **BRIMARIZE!**

Standard Telephones and Cables Limited

FOOTSCRAY · SIDCUP · KENT FOOtscray 3333

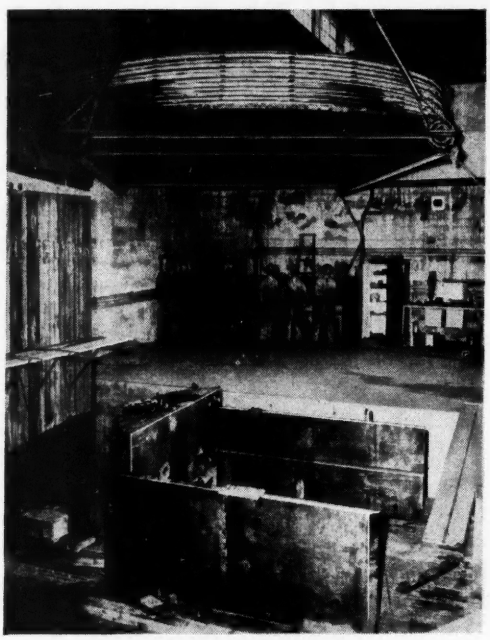


The aluminium being pulled through a tensioning device and wound on to the layer of pancakes that form the magnet energizing coils.



The completed job being lifted from the winding table. The partially built accelerator magnet is shown in the foreground.

CYCLOTRON WINDINGS



Another view of the completed winding.

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Photographs — reproduced by courtesy of the University — show the job in progress.

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FREQUENCY RESPONSE:	*Flat to within ±1 db over the whole working range.*
LEVEL STABILITY:	*±1 db if mains supply voltage remains within ±5%*
ACCURACY OF HARMONIC MEASUREMENTS:	*Harmonics below fundamental* *to −55 db ±5%* *to −75 db ±10%* *or ±1 db whichever is the greater.*
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SELECTIVITY:	*Constant over the frequency range. 2 stage crystal filter, mid band frequency 100 Kc/s. Flat top (±1 db) pass band extending over 10 c/s ±1 c/s.*
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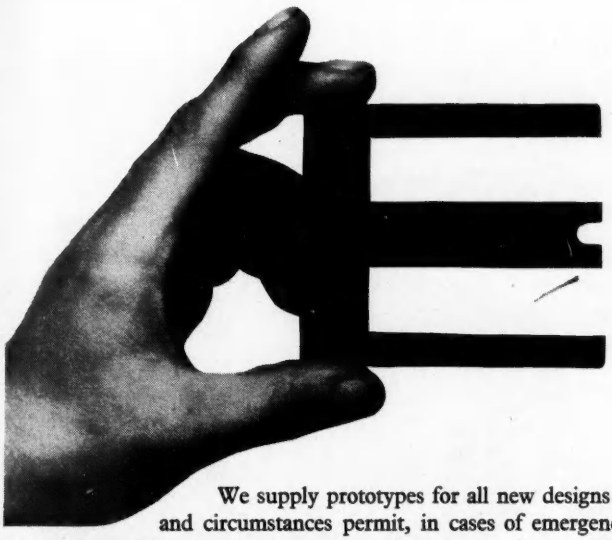

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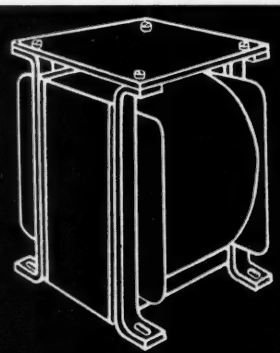

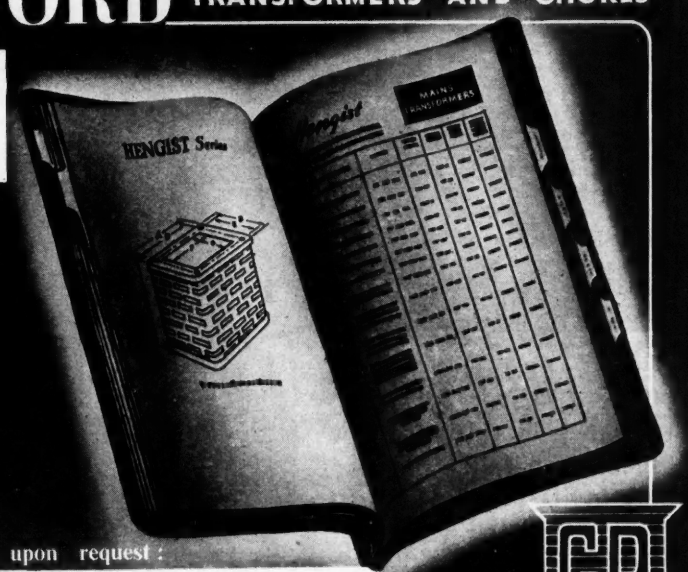

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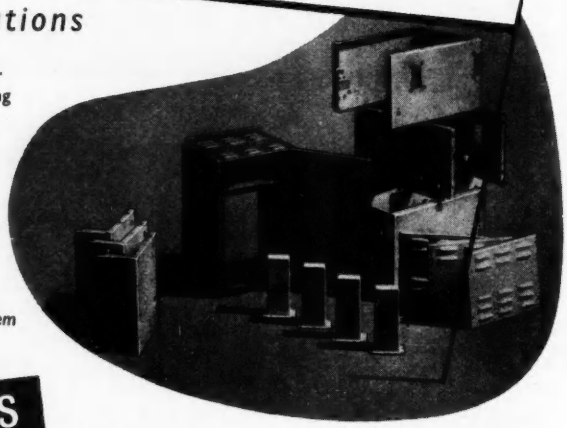

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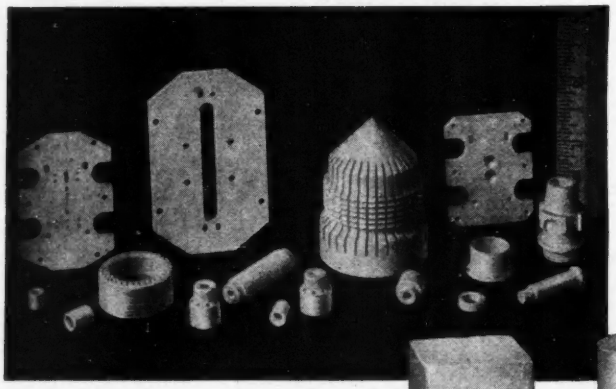

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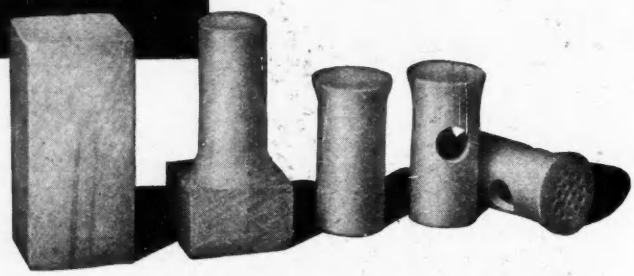

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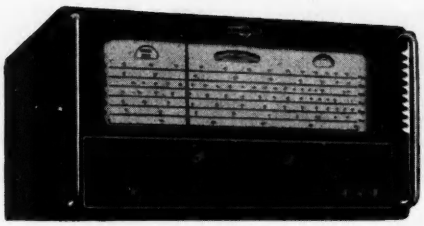

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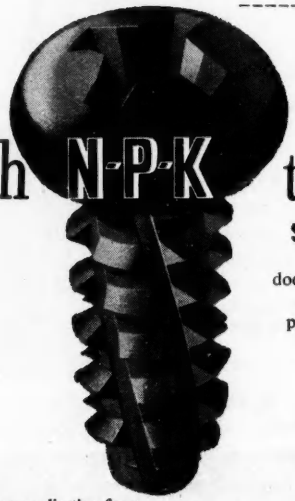

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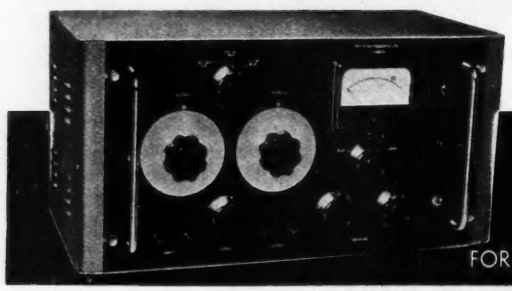

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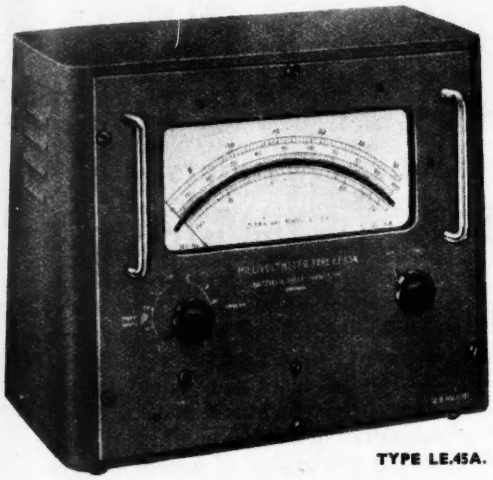

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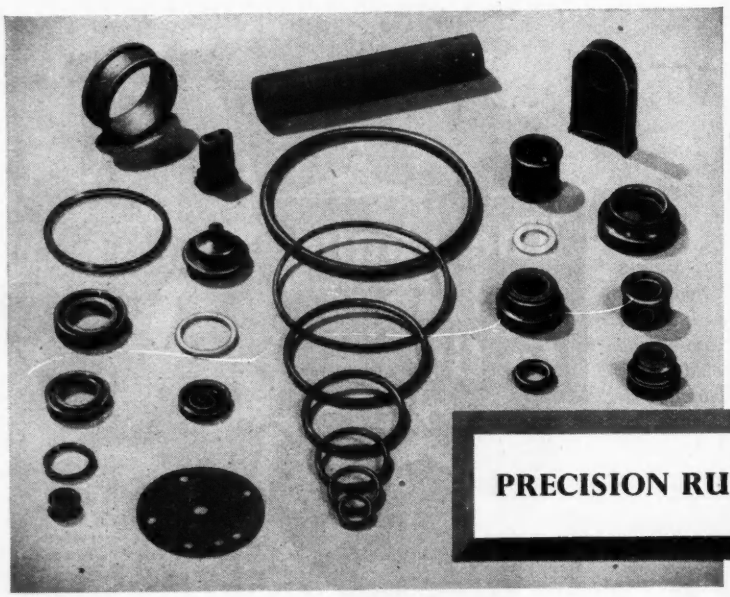

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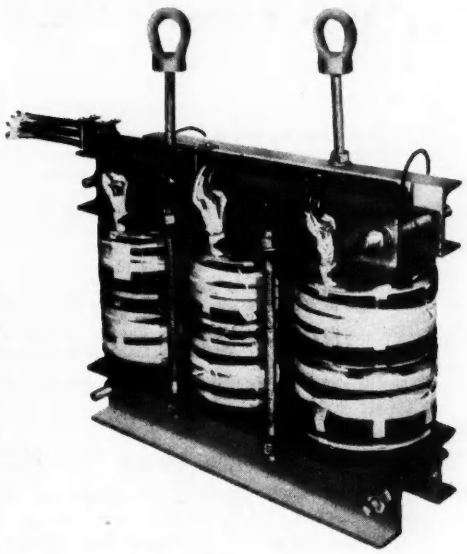

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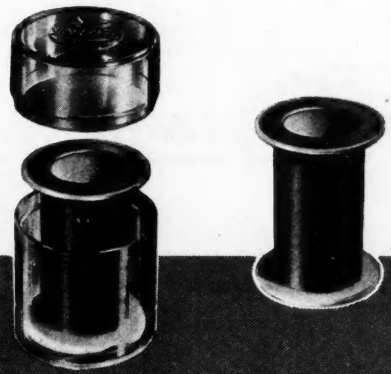

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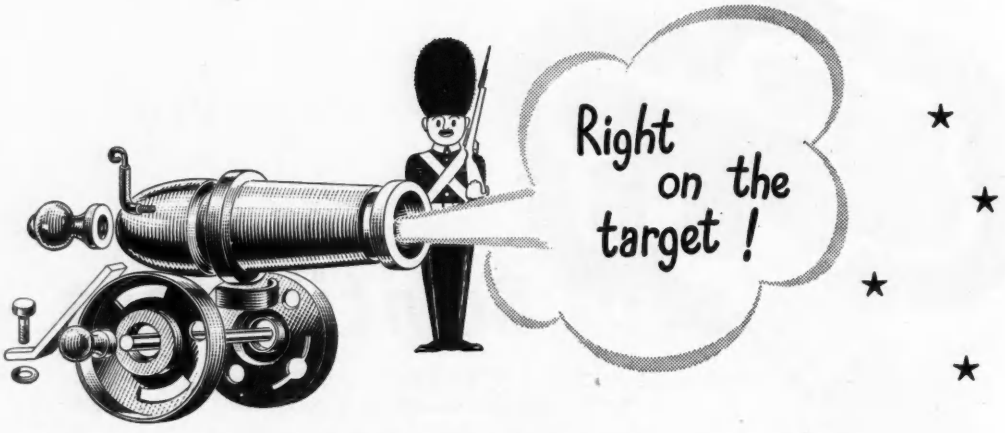

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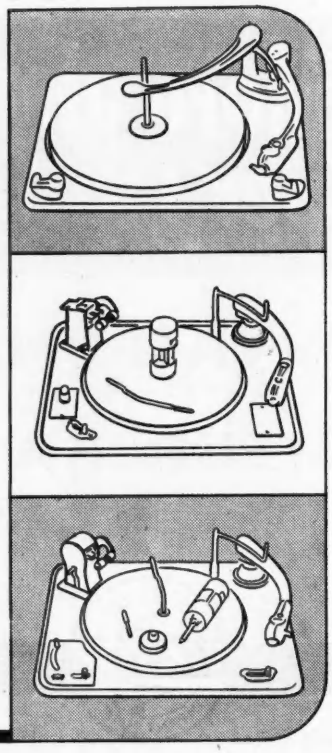

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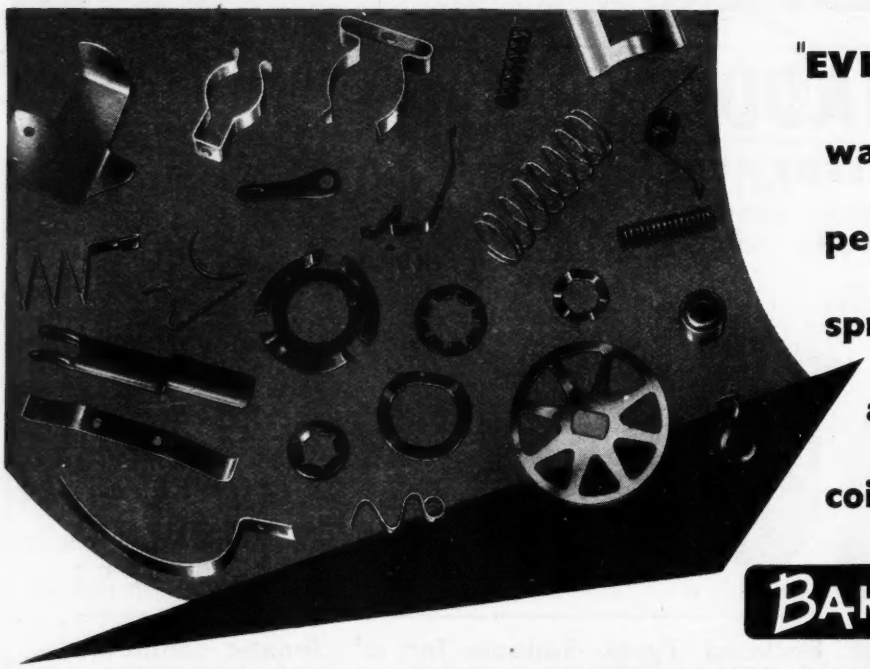

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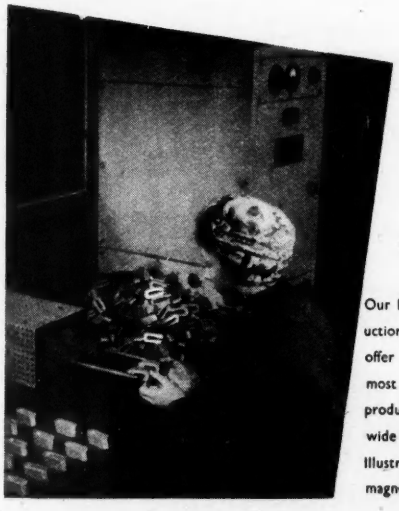

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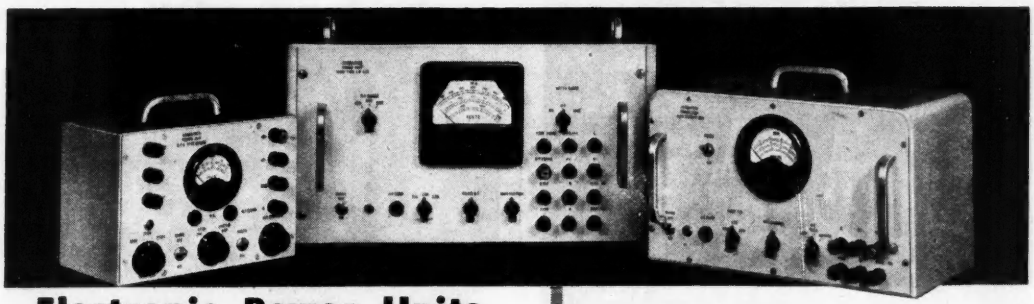

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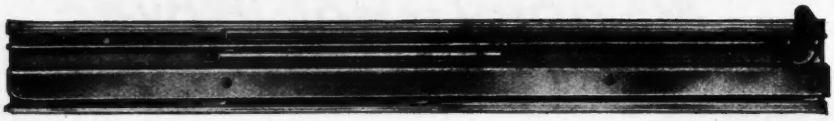

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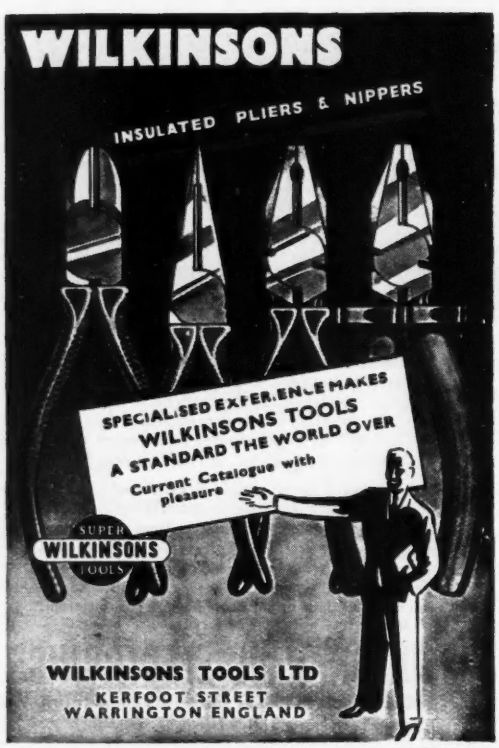

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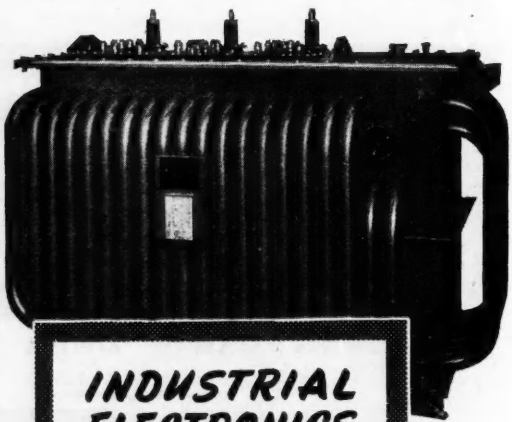

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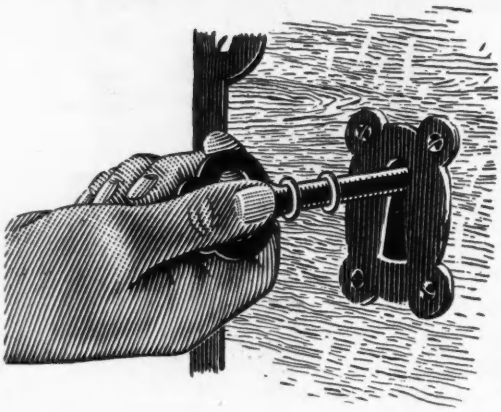

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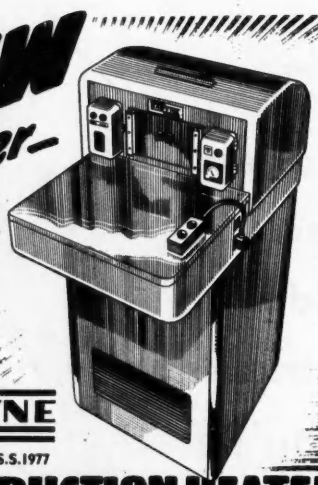

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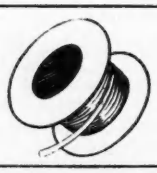

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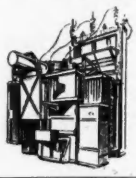

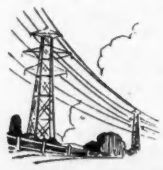

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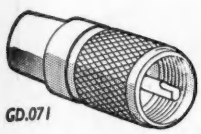
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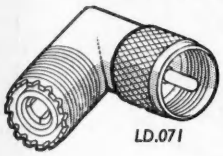
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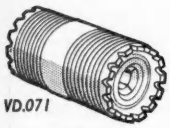
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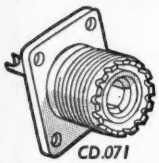
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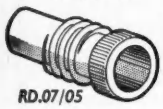
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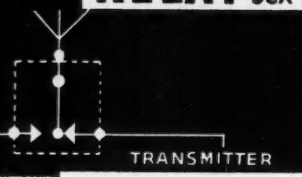

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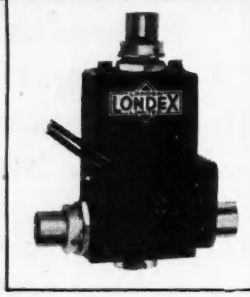

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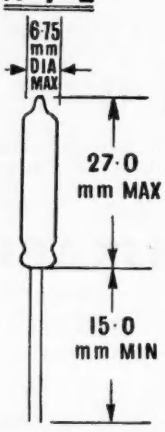

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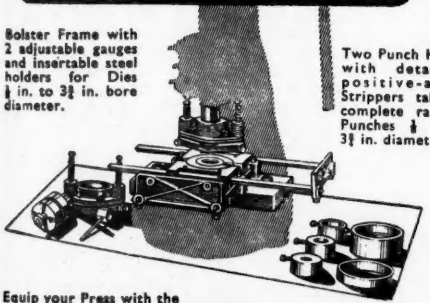

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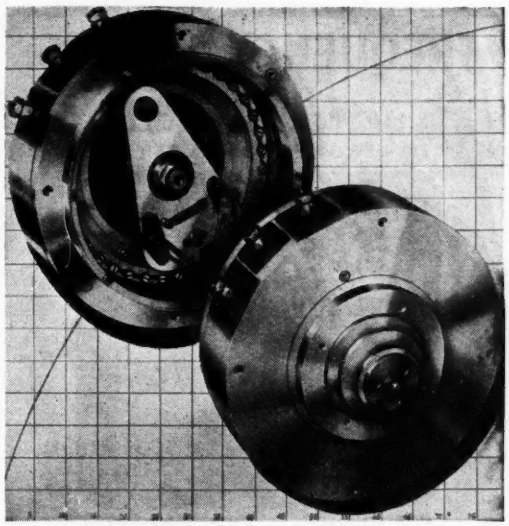

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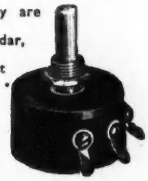

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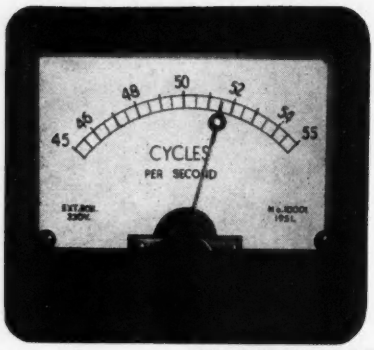

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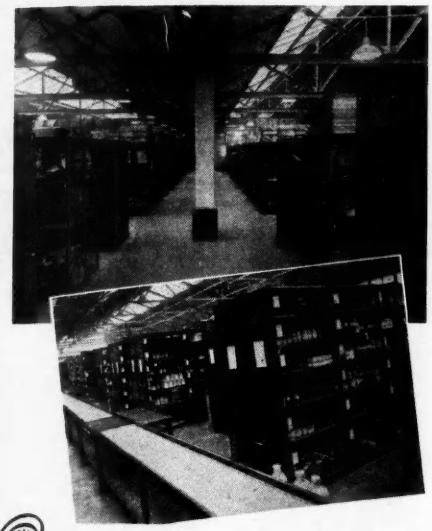

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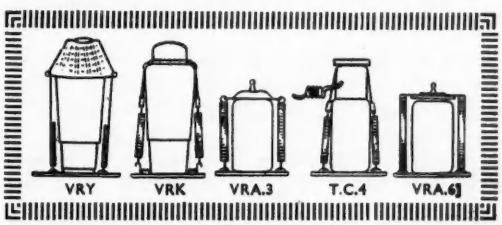

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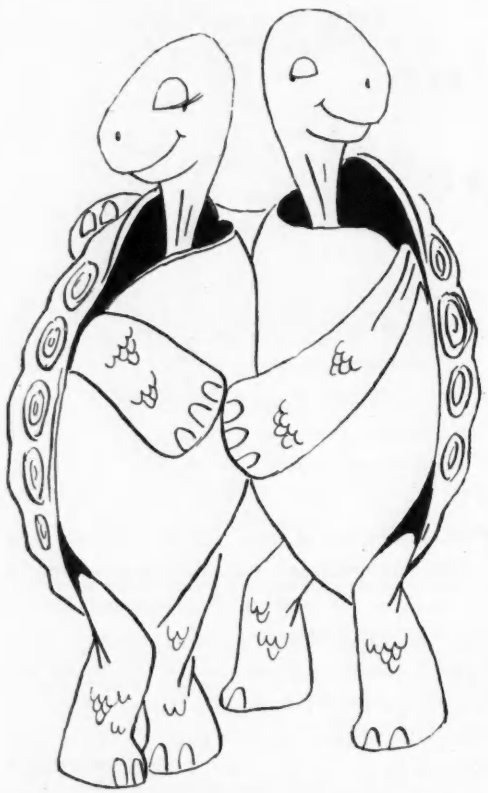

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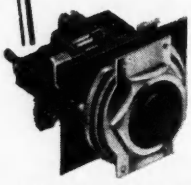

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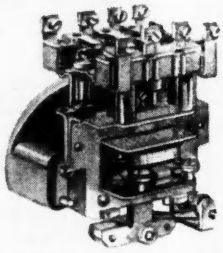

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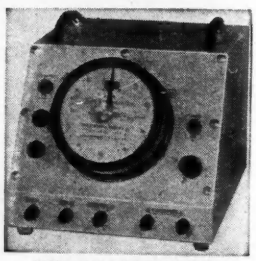

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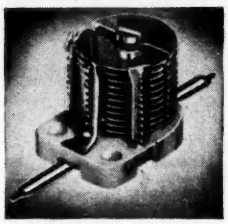

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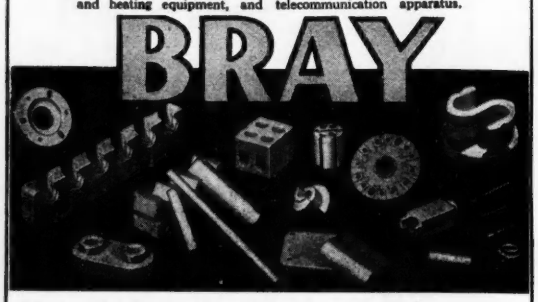

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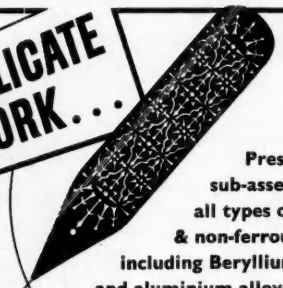

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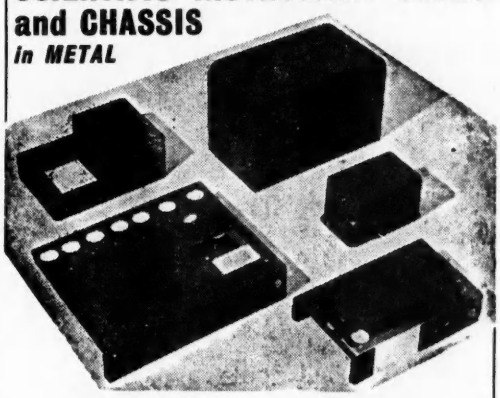

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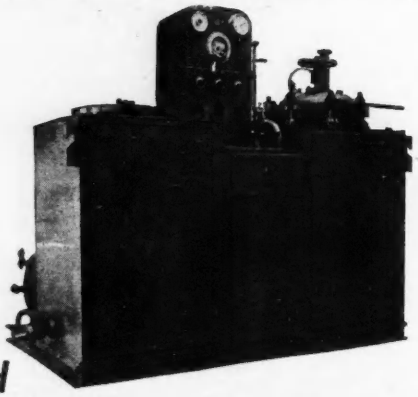

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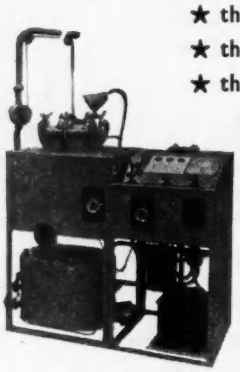

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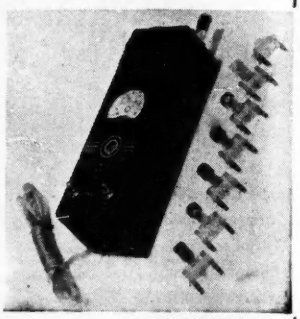

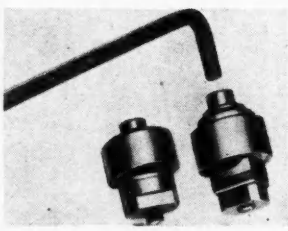

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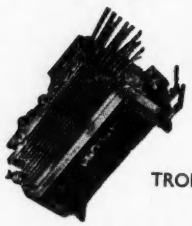

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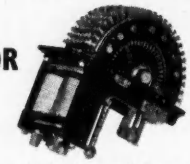

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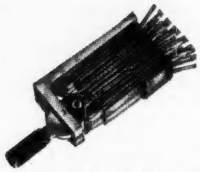

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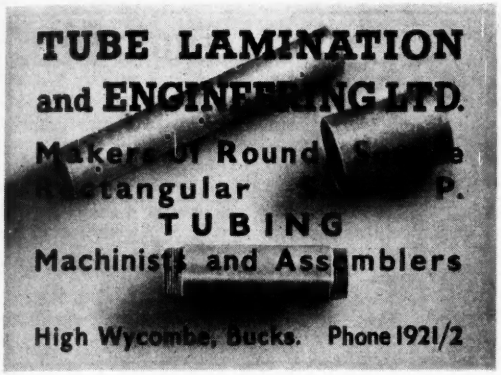

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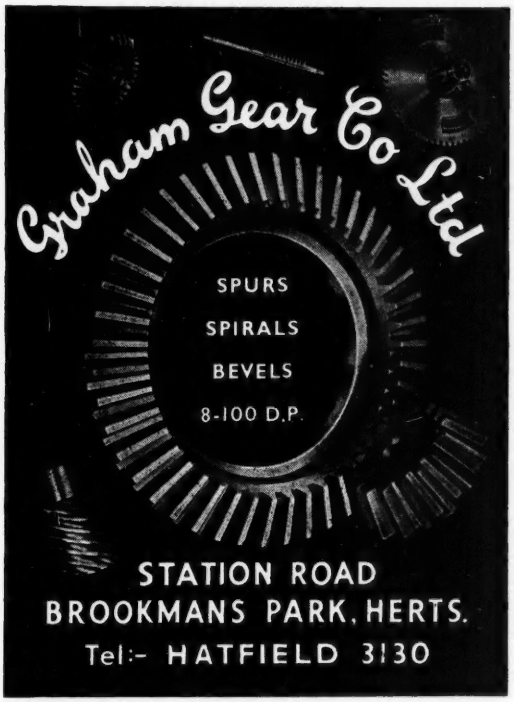

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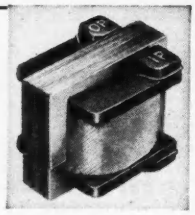

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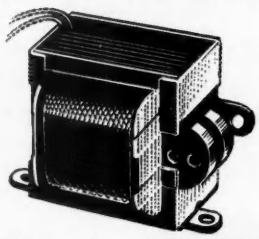

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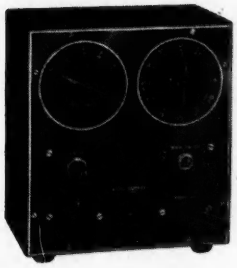

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INDEX TO ADVERTISERS

A.D.S. Relays Ltd. 110
Advance Components Ltd. 72
Aero Research Ltd. 31
Airmec Ltd. .. .. 44 and 85
Allnutt & Co., Thos 110
All-Power Transformers Ltd. 74
Amplex Appliances (Kent) Ltd. .. 110
Anders Electronics 110
Antex Ltd. 95
Autoset (Production) Ltd. 94

Baker & Finnemore Ltd. 90
Baldwin Instrument Co., Ltd. .. 93
Barlow-Whitney Ltd. 106
Bell & Croyden, John 110
Belling & Lee Ltd. 71
Berry's (Shortwave) Ltd. 106
Bird & Sons Ltd., Sydney, S. .. 70
Birlec Ltd. 3
Blickvac Ltd. 106
Booth & Co., Ltd., James 77
Boulton-Paul Aircraft Ltd., ... 93
Bradmatic Ltd. 106
Brandauer & Co., Ltd., C. 105
Bray & Co., Ltd., George 104
Brayhead Springs Ltd. 108
British Communications Corporation Ltd. 69
British Electric Resistance Co., Ltd. 92
British Insulated Callender's Cables Ltd. .. .. Cover 1
British Physical Laboratories Ltd. .. 92
Broxlea Products Ltd. 91
Burndept Ltd. 97

Chapman & Hall Ltd. 175
Chase Products (Engineering) Ltd. .. 105
Cinema-Television Ltd. 73
Cleaver-Hume Press Ltd. 175
Collard Hart Ltd., H. 109
Colvern Ltd. 99
Connollys (Blackley) Ltd. 68
Cooper & Co. (Birmingham) Ltd. .. 105
Cossor Ltd., A. C. 29
Cressall Manufacturing Co., Ltd., The 104
Croydon Precision Instrument Co. .. 105

Darwins Ltd. 91
Davis (Relays) Ltd., Jack 108
Davis, Wynn & Andrews Ltd. .. 102
Dawe Instruments Ltd. 90
Donovan Electrical Co., Ltd. 102
Duratube & Wire Ltd. 102

Edison Swan Electric Co., Ltd., The Cover 2, 45 and 67
Eddystone Radio 81
Electrical Instrument Co. (Hillington) Ltd., The 100
Electro-Methods Ltd. 100
Electrothermal Engineering Ltd. .. 101
Electronic Engineering Monographs 174 and 108
Electronic Laminations 79
Elliott Bros. (London) Ltd. 54
E.M.I. Factories 19
E.M.I. Institutes Ltd. .. .. 99 and 100
Empire Rubber Co., Ltd. 51
English Electric Co., Ltd., The .. 46
Enthoven & Sons Ltd., H. J. 66
Epsylon Research & Development Co., Ltd. 47
Ericsson Telephones Ltd. 63
Erie Resistor Ltd. .. .. Cover 3
Evertaut Ltd. 101

Farnell Ltd., A. C. 109
Ferranti Ltd. .. .. .. 53 and 59

Gardner's Radio Ltd. 79
Garrard Engineering & Manufacturing Co., Ltd., The 88
General Electric Co., Ltd., The .. 27
Goodman's Industries Ltd. 65
Graham Gear Co., Ltd. 109
Gresham Transformers Ltd. 48
Griffiths, Gilbart, Lloyd & Co., Ltd. 88
Guest, Keen & Nettlefolds (Midlands) Ltd. 81

Haddon Transformers Ltd. 89
Hairlok Co., Ltd., The 83
Hallam, Sleigh & Cheston Ltd. .. 89
Harboro' Rubber Co., Ltd. 109
Harrison Bros. (Plastics) Ltd. 100
Hassett & Harper Ltd. 60
Hatfield Instruments Ltd. 83
Hill Ltd., C. & L. 58
Hivac Ltd. 98
Hunton Ltd. 99

Isotope Developments Ltd. 87

Johnson, Matthey & Co., Ltd. .. 57

Kempe's Engineers' Year Book .. 174

Langham Thompson Ltd., J. .. 43 and 75
Linread Ltd. 62
Londex Ltd. 98
London Electric Wire Co. & Smiths Ltd. & Vactite Wire Co., Ltd. .. 87
London Office Machines Ltd. 86
Lyons Ltd., Claude 42

Magnetic & Electrical Alloys Ltd. .. 41
Magnetic Devices Ltd. 21
Marconi Instruments Ltd. 40
Marconi's Wireless Telegraph Co., Ltd. 33
Measuring Instruments (Pullin) Ltd. .. 38
Metachemical Processes Ltd. 28
Metropolitan Plastics Ltd. 25
Metropolitan-Vickers Electrical Co. Ltd. 35
Micanite & Insulators Ltd. 52
Microwave Instruments Ltd. 55
Miltoid Ltd. 98
Muirhead & Co., Ltd. 34
Mullard Ltd. .. .. 30, 37, 56, and 64
Murex Ltd. 112

Nagard Ltd. 26
Neill & Co. (Sheffield) Ltd., James .. 84
New Electronic Products Ltd. 86
Nu-Swift Ltd. 109

Oxley Developments Ltd. 103

Painton & Co., Ltd. 24
Parmeko Ltd. 5
Patterson & Partners Ltd. 103
Pell Control Ltd., Oliver 61
Pitman & Sons Ltd., Sir Isaac 103 and 107
Power Controls Ltd. .. .. 11 and 39
Powis & Sons Ltd., David 107
Precision Rubbers Ltd. 84
Prescott Manufacturing Co., Ltd. .. 107
Presspahn Ltd. 107
Pye Ltd., W. G. 85

Radio Heaters Ltd. 96
Radiospares Ltd. 107
Ragosine Oil Co., Ltd. 96
Rees-Mace Marine Ltd. 9
Reliance Manufacturing Co. (Southwark) Ltd. 107
Ritherdon & Co., Ltd. 103
Rivlin Instruments Ltd. 82

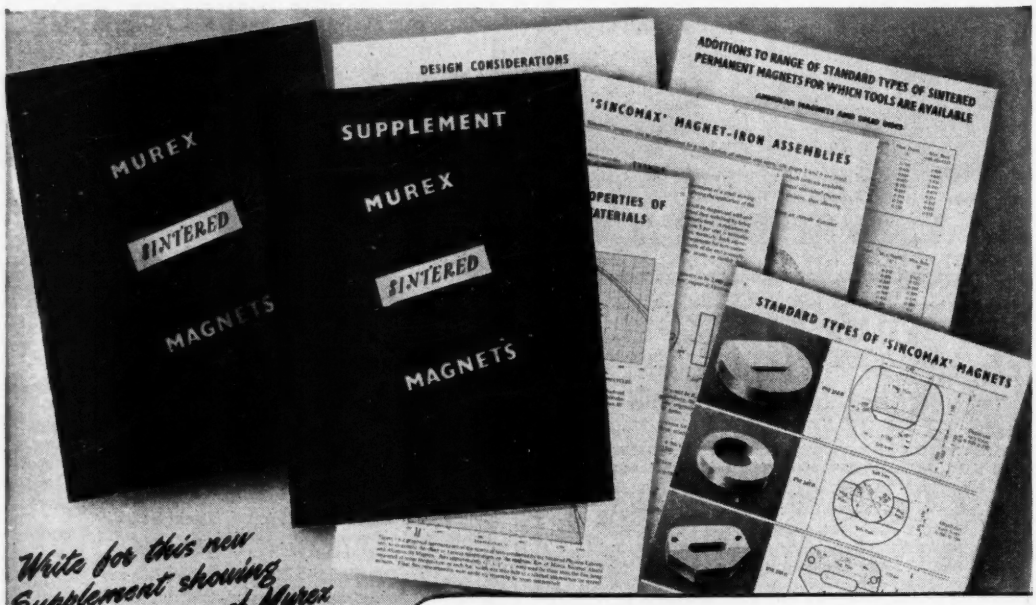
Salford Electrical Instruments Ltd. .. 36
Sanigaard Appliances Ltd. 82
Saunders-Roe Ltd. .. .. 22 and 23
Scott & Electromotors Ltd., Laurence 15
Servo & Electronic Sales Ltd. 111
Servomex Controls Ltd. 13
Solartron Laboratory Instruments Ltd. 7 and Cover 4
Spear Engineering Co., Ltd. 111
Spencer & Sons (Market Harboro) Ltd. 80
Spurrell Ltd., R. W. 111
Standard Telephones & Cables Ltd. 20, 32 and 76
Sugg & Co., Ltd., William 80
Sunvic Controls Ltd. 50
Sutton Coldfield Electrical Engineers .. 111
Synthetic Supplies Ltd. 111

Tan-Sad Chair Co. (1931) Ltd. 95
Taylor Tunnicliff & Co., Ltd. 18
Telegraph Construction & Maintenance Co., Ltd. 14
Tetra Engineering Co., Ltd. 97
Transradio Ltd. .. .. .. 97 and 104
Tube Laminations Ltd. 109
Twentieth Century Electronics Ltd. 49

Unbrako Socket Screw Co., Ltd. .. 16

Venner Accumulators Ltd. 17

Watson Ltd., R. & W. 96
Wayne-Kerr Laboratories Ltd. 78
Webber Ltd., R. A. 111
West London Rewind Service Ltd. .. 111
Whiteley Electrical Co., Ltd. 3
Wilkinson, L. 111
Wilkinson's Tools Ltd. 94
Woden Transformer Co., Ltd. 94



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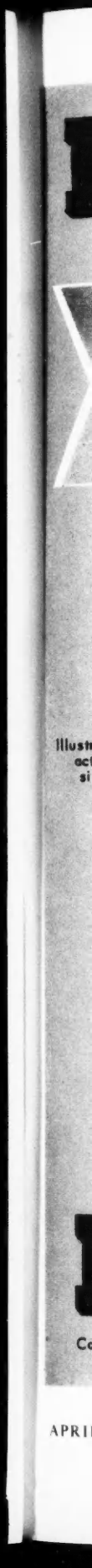

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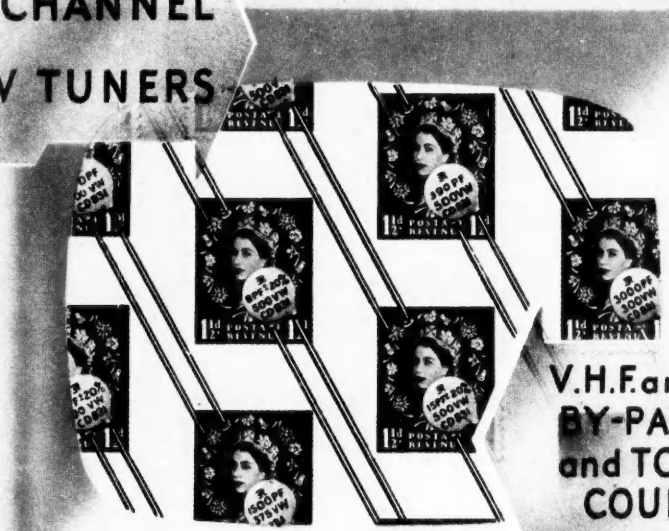

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